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United States Department of the Interior
Fish and Wildlife Service

CENTRAL NEW ENGLAND
FISHERIES RESOURCE COMPLEX
151 Broad Street
Nashua, New Hampshire 03060

April 17, 2001

Mr. Joseph F. LeMay, P.E.
Remedial Project Manager
Office of Site Remediation and Restoration
US Environmental Protection Agency
1 Congress Street, Suite 1100
Boston, Massachusetts 02114-2023

Joe

Dear Mr. ~~LeMay~~:

I have enclosed five final copies of the "Fishery Survey, Industri-Plex Site, Woburn, Massachusetts". I have provided copies to Fish and Wildlife Service staff who were involved in the project.

Thank you for the opportunity to assist in the work associated with the Industri-Plex Site, and if you have questions then please contact me at your convenience at (603) 528-8750.

Sincerely,

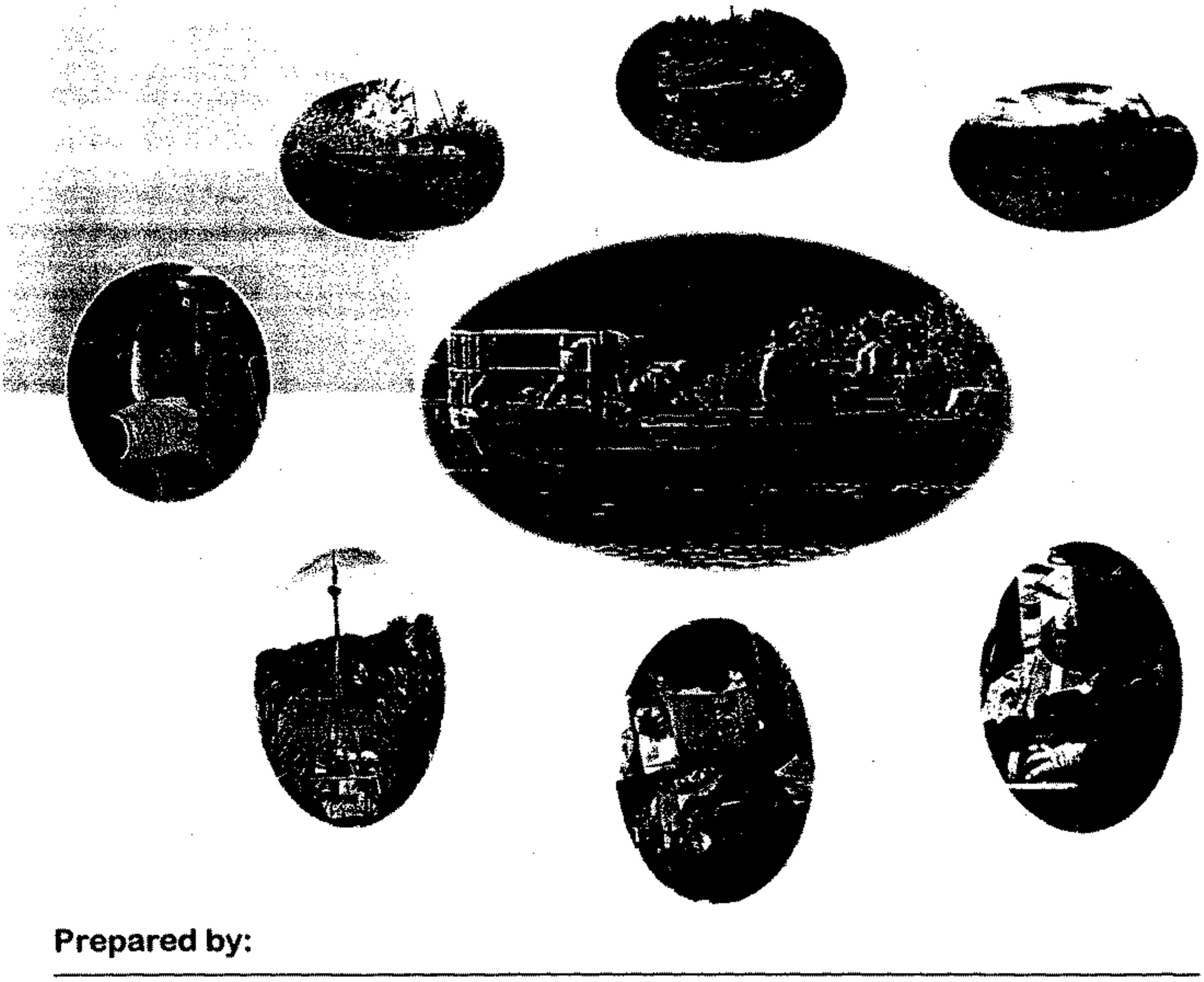
Joseph F. McKeon
Supervisory Fishery Biologist

cc: Munney, K., USFWS, NEFO
Meirzycowski, S., USFWS, MEFO

enclosures

April 2001

Fishery Survey
Industri-Plex Site
Woburn, Massachusetts



Prepared by:

Department of Interior
U.S. Fish and Wildlife Service
Central New England Fisheries Resource Office
Nashua, New Hampshire

FISHERY SURVEY
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Prepared by:

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April 2001

Acknowledgments

The U.S. Fish and Wildlife Service, Office of Fishery Assistance, Laconia, N.H. provided oversight during field sampling at the Industri-Plex Site in June 1999. We thank Steve Mierzykowski, Ken Munney, and Tim Pryor, New England Field Office, U.S. Fish and Wildlife Service, Concord, N.H. and Kevin Scheirer, Everett McLaughlin, Office of Fishery Assistance, U.S. Fish and Wildlife Service, Laconia, N.H. for their assistance in the field work. Charlene Brown, Administrative Office Assistant, Office of Fishery Assistance, Laconia, N.H. was responsible for creating data charts and tables, as well as the design, formatting and typing of this document.

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At the time of this survey drought conditions had persisted across the State of Massachusetts for quite some time, and it is now noted in the report that this regional weather/climatic event may have altered water levels and water temperature in HBHA Pond, HBHA Pond No. 3 and South Pond (Item 5). In Tables 7 and 8, Proportional Stock Density (PSD) and Relative Stock Density (RSD) values for bass in the Site ponds are compared to other waterbodies in New Hampshire and Connecticut. It is recognized that the waterbodies used for comparisons are significantly larger than the ponds at the Site, however values presented were the only data found to be available (Items 6 and 7). A Summary and Conclusions section has been added to the report and information included in the body of the report addressing physical habitat quality features of the ponds with respect to their ability to support different fish species (Items 8 and 9).

An earlier statement indicating "it is possible that small bass were overlooked due to the directed effort at capturing large fish to ensure adequate tissue samples for laboratory analysis" has been revised. The text now reads: "At the time of this survey drought conditions had persisted across the State of Massachusetts. The surface water table was extremely low, particularly for HBHA Pond No.3 and South Pond. Such conditions may have negatively affected aquatic habitat and abundance of fish in the ponds. Stock structure indices for both HBHA Pond No. 3 and South Pond may also have been affected by minor sample bias. Some small fish of all species, though observed, were not captured in these ponds. It is possible that a few small (≈ 150mm) bass were misrepresented as other species and thus overlooked or not captured due to the directed effort at capturing larger fish (>150mm) to ensure adequate tissue samples for laboratory analyses." It should be noted that only bass ≥150mm were used to develop PSD values for the ponds and thus values would not be effected if smaller bass were overlooked. In addition, it is likely that very few small bass were overlooked and therefore species composition figures should be quite accurate (Item 10).

Review comments addressing the function of HBHA Pond as a retention basin, and the fact that individuals have been observed fishing and perhaps consuming fish at sites near the pond are acknowledged (Items 11 and 12). Lastly, the three concluding paragraphs in the draft document discussing recreational angling opportunities have been deleted from the report (Item 13).

In our telephone conference on February 27, 2001 you asked if I could address an issue related to fish consumption rates given that EPA staff had observed fishing camps on HBHA Pond. The fishery survey was not designed to directly address this request, and since there is not an accurate evaluation of how much fish and what types of fish anglers are ingesting, fish ingestion rates would need to be estimated. Three possible scenarios were presented for consideration: a) one 6 ounce fish meal per week for 7 months/year = total of 4759 grams of fish/year and a total of 168, 6 ounce fish meals/year; b) one 8 ounce fish meal per week for 7 months/year = total of 6345 grams of fish/year and a total of 224, 8 ounce fish meals/year; and c) two 8 ounce fish meals per week for 7 months/year = total of 255550 grams/year and a total of 56, 8 ounce fish meals/year.

Based on the species and size of fish captured in HBHA Pond (Appendix G) it seems reasonable to assume that subsistence anglers would target largemouth bass, white sucker or brown bullhead for consumption. While the numbers of bullhead (3) and bass (9) captured in HBHA Pond were limited, a moderate number of white suckers (57) were captured, and the percent composition of this species in the pond as well as in HBHA Pond No. 3, located not too distant downstream from HBHA Pond, was quite similar. Accordingly, it is not unreasonable to assume that HBHA Pond could support a harvest rate that would achieve scenario (b) in a single year: one 8 ounce fish meal per week for 7 months/year = total of 6345 grams of fish/year and a total of 224, 8 ounce fish meals/year. Since the survey was not designed to develop population estimates or age structure of fish species in the ponds, it is not possible to determine whether this annual yield would be sustained for the three fish species individually or in aggregate given the stated harvest or exploitation rate.

Thank you for the opportunity to assist your agency in understanding the fish population and community structure in the ponds located adjacent to the Industri-Plex Site. I have incorporated comments and suggestions into the fishery survey report and if you have questions please contact me at your convenience at (603) 528-8750.

Sincerely,

Joseph F. McKeon

Joseph F. McKeon
Supervisory Fishery Biologist

cc: Munney, K., USFWS, NEFO
Meirzycowski, S., USFWS, MEFO

attachments

EPA Draft Comments on
U.S. Fish and Wildlife Service's
Draft Fishery Survey at Industri-Plex Superfund Site,
Woburn, Massachusetts, dated April 2000

1) General (TTNUS): A physical description of each pond including general condition, acreage, water depths, spawning habitat presence, vegetation types, structure, etc., would be useful for data assessment.

2) General (TTNUS): It should be noted that beaver activity at Phillips Pond had raised the pond water level an estimated 2 feet or more at the time of the fish survey. This should be taken into consideration during the discussions. The resultant flooding had significantly increased the littoral area in Phillips pond.

3) Page 1, Introduction, a - f (TTNUS): These objectives are somewhat misleading and give the reader the impression that all these objectives are addressed in this report. This section should be clarified or state that these objectives are being accomplished by Menzi-Cura through the Final GSIP Ecological Risk Assessment. Specifically, Objectives e.) and f.) are not addressed in the draft version of the report and some portions of the other objectives are not complete.

4) Page 8, 1st paragraph (TTNUS): The last phrase indicates that the lack of abundance of smaller bass could be due to "the impacts of chemical contamination". This report does not address chemical contamination in the ponds, chemical concentrations in fish tissues, or the impacts of these contaminants. This phrase should be removed from the text. The text should explain that the impacts of chemical contamination will be evaluated under the ecological and human health risk assessments.

5) Page 8, Results and Discussions: The document needs to record the weather/ climatic conditions encountered during the June 1999 Fishery Survey. During the Spring and early Summer, drought conditions were encountered across Massachusetts during the Fishery Survey. The surface water table was extremely low during the survey, especially for the shallow HBHA Pond 3 and South Pond. The drought conditions should be documented and discussed in the report. The drought conditions may have impacted fish population, size and diversity fish collected/observed during the survey. Please elaborate in the document.

6) Results and Discussion section, Tables 7 and 8 (TTNUS): In the tables there are comparisons of Proportional Stock Density (PSD) and Relative Stock Density (RSD) values observed in the Industri-plex site ponds to other water bodies in New Hampshire and Connecticut. With the exception of Mass Cove on the Connecticut River, all water bodies used for comparison are significantly larger than those at the Industri-plex site. It would be more useful to present data from comparatively-sized ponds in relatively similar environmental settings (urban vs. rural), if available.

7) Results and Discussion section, Table 8 (TTNUS): It states that the New Hampshire ponds

were "selected" for comparison to Industri-plex. The basis for selection of these ponds should be stated in the discussion.

8) Results and Discussion section (TTNUS). The section is somewhat fragmented. The final paragraph section should summarize the factors observed at the site ponds that may be impacting the fish populations (i.e. shallow depth, lack of suitable/sufficient vegetation in the littoral zone, lack of irregular shoreline and submerged structures, dissolved oxygen concentration, etc.).

9) Results and Discussion section (TTNUS): The section should also present a discussion of how the observed physical conditions at the Industri-plex site ponds may impact fish species other than small/largemouth bass. This would fully address Objective C. - "generally evaluating physical habitat quality features of the ponds with respect to their ability to support different fish species".

10) Page 10, 1st paragraph (TTNUS): The statement "It is possible that small bass were overlooked due to the directed effort at capturing large fish to ensure adequate tissue samples for laboratory analysis" is troubling. This statement leads the reader to think that the discussions and comparisons presented in Tables 7 and 8 may also be inaccurate because of a sampling bias that targeted larger fish. The impacts of the sample bias should be considered in all aspects of the Results and Discussion section.

11) Page 10, Results and Discussions: The text states, "If the HBHA Pond functions as a retention basin, water levels may fluctuate in spring due to runoff from snow melt and storm events, as well as, increased impermeability around the site. Frequent events may also result in water fluctuations that reduce prey availability for juvenile and adult base life stages." Based upon my observations of the water levels within the HBHA Pond, I do not believe the HBHA Pond is serving as typical retention basin, and I do not believe the water levels significantly fluctuate. Based upon the GSIP Phase 1 and 2 reports and visual observations of the HBHA Pond, a majority of the water in the pond is a result of groundwater discharge. Over the years, I have not observed significant surface water level fluctuations within the HBHA Pond. I estimate the surface water level within the pond may fluctuate up to 2 feet over an average one year period. With regard to increased impermeability around the site, at the time of the survey their should not have been an increase impermeability around the site. The 36 acre Regional Transportation Center Alternative Cover immediately to the north of the HBHA Pond was covered with crushed stone, which would have increased permeability. Three of the four animal hide piles located north of the HBHA Pond were covered with permeable covers, which would not have changed the permeability significantly prior to the remedy. The most significant surface water discharge into the HBHA Pond is from Halls Brook (west side of pond). This brook discharges approximately 1/3 of the distance from the northern boundary of the pond. It is possible that high flow events may increase turbidity near this discharge, and possibly affect eggs and fry near the discharge area.

12) Page 11, Results and Discussions: The text states, "Given the size of bass observed in the ponds, the potential for harvesting fish in a recreational fishery is limited. ... The number and size of bass observed in HBHA Pond limits the potential for recreational angling opportunities."

In the Spring 2000, EPA observed and photographed a camp established along the northern bank of the HBHA Pond (under the Boston Edison ROW) for fishing. According to the Woburn Police Department (WPD), they regularly observe ethnic populations (Asian Heritage) fishing in HBHA Pond, cooking fish on an open fire along the northern bank of the HBHA Pond, and consuming the cooked fish. EPA will attempt to interview the WPD and document this matter further.

13) It is suggested that the last three paragraphs of the Results and Discussion section should be removed from the Fish Survey. The objectives of this study did not include providing recommendations for improving recreational opportunities. On the contrary, recreational fishing is discouraged until studies are completed that assess human health risk exposure to potentially contaminated sediments at the shoreline and/or through fish consumption.

U. S. ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND
OFFICE OF ENVIRONMENTAL MEASUREMENT & EVALUATION
OFFICE OF ECOSYSTEM ASSESSMENT
60 WESTVIEW STREET, LEXINGTON, MA 02421

MEMORANDUM

DATE: July 5, 2000

SUBJ: Review of *Draft Fishery Survey, Industri-Plex Site, Woburn, Massachusetts*

FROM: Patti Lynne Tyler
Aquatic Biologist/Ecological Risk Assessor

TO: Joe LeMay
Remedial Project Manager

Thank you for the opportunity to review and provide technical comments on the above referenced document. Comments are attached to this memorandum. Please do not hesitate to contact me should you have any questions or comments with respect to this review.

cc: Peter Nolan EPA/OEME/ECA

INTRODUCTION

This report provides a compilation of data, and a review of the results of fish sampling conducted by personnel from the U.S. Fish and Wildlife Service and Menzie-Cura Associates, Inc. in June 1999 at the Industri-Plex Site located in Woburn, Massachusetts. Fish were collected from two potentially contaminated sites that included Halls Brook Holding Area Pond (HBHA Pond) and Halls Brook Holding Area Pond No. 3 (HBHA Pond No. 3), as well as two reference sites identified as South Pond and Phillips Pond.

The purpose of sampling fish and conducting other analyses is supported by the Toxicological Surface Water, Sediments Sampling and Quality Assurance Project Plan for the Industri-Plex Site Woburn, Massachusetts (Menzie-Cura & Associates, Inc. 1999). The Plan identified that this field work was being performed for the Industri-Plex Remedial Trust (ISRT) under the direction of U.S. Environmental Protection Agency, Region 1.

In addition, the Plan identified a need to fill data gaps of previous investigations and to augment existing data for use in ecological and human health risk assessments. Accordingly, fish samples were collected from ponds at the Industri-Plex Site to achieve a number of objectives that included:

a. identifying the composition and general abundance of fish in the ponds and examining whether HBHA Pond and HBHA Pond No. 3 were depauperate in species composition and relative abundance in comparison to reference sites, South Pond and Phillips Pond;

b. examining the age structure and the length and weight relationships for an identified target species, largemouth bass, in the ponds;

c. generally evaluating physical habitat quality features of the ponds with respect to their ability to support different fish species;

d. determining the potential for recreational angling opportunities in the ponds;

e. determining body burdens of chemicals in fish tissue for use in Ecological Risk Assessment and Human Health Risk Assessment; and

f. examining fish for gross histopathological anomalies and comparing these between the HBHA Ponds and the reference ponds.

While this report provides specific data relevant to objectives a. through d., fish specimens collected during the survey will also be used to address objectives e. and f. It is intended that these objectives will be considered in evaluations and examinations of ecological and human health risk assessments that are not within the scope of this fishery survey.

METHODS

Fish were collected for this study by boat electrofishing and by using gill nets, trot lines and eel pots (Figures 1-4). Electrofishing occurred in areas that included all habitat strata. Fish were captured in shallow water areas adjacent to the shoreline, and in and along the edges of emergent vegetation. Fish were also captured in deeper water which included water depths that approached 4.5m. Fish were stunned and captured or enumerated using a 5.5m boom-type, direct current electrofishing boat. Sampling in all ponds was stratified into ten minute blocks and each block was designated as a run. The proximity of runs in each pond, including the point of origin and termination, is shown in Figures 1-4.

The timed runs permitted a simple measure of relative abundance, expressed as fish captured per minute or catch-per-unit effort (CPUE). Gill nets were deployed during electrofishing in HBHA Pond to increase capture efficiency in deep water areas (Figure 1). However, only fish captured by electrofishing were used to calculate CPUE.

CPUE for electrofishing was calculated as fish (f/min) based on actual sampling time in the ponds. CPUE was not determined for South Pond or HBHA Pond No. 3 because systematic timed runs were not completed in these ponds. An abundance of vegetation in South Pond, and shallow water in HBHA Pond No. 3, limited boat operations in these ponds. All fish collected in each pond for laboratory analyses were placed in live wells upon capture. At the time of processing and packaging, fish were removed from the live wells, measured to the nearest millimeter total length, weighed to the nearest gram, and examined externally for abnormalities such as tumors and lesions. Total length and weight of fish and abnormalities if observed, were noted on field data sheets for each pond.

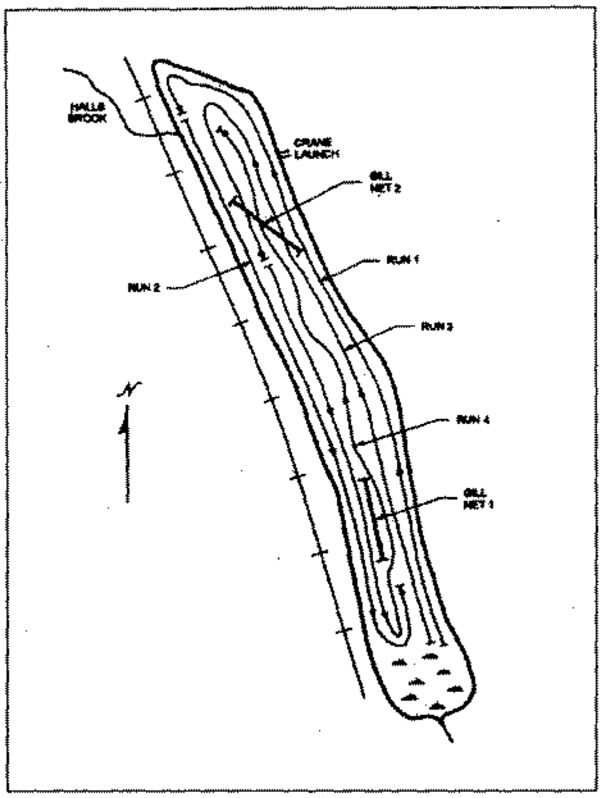


Figure 1. Locations of electrofishing runs in Halls Brook Holding Area Pond, Industri-Plex Site, Woburn, MA.

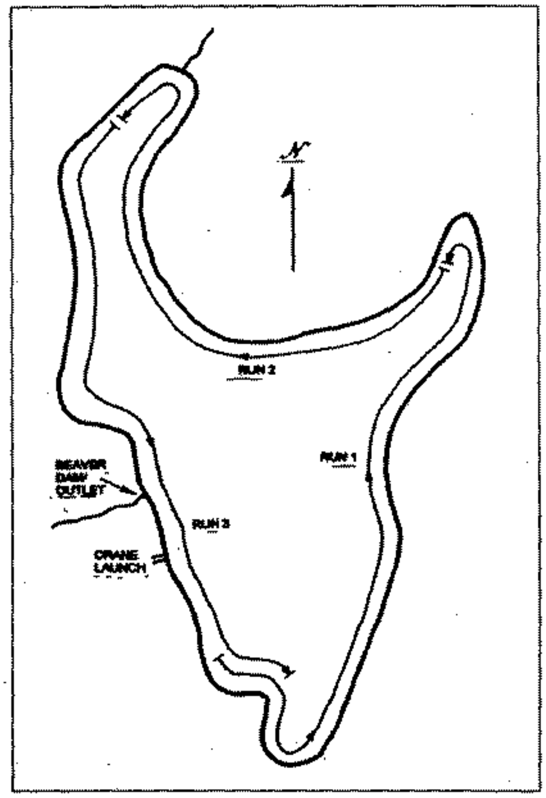


Figure 2. Locations of electrofishing runs in Phillips Pond, Industri-Plex Site, Woburn, MA.

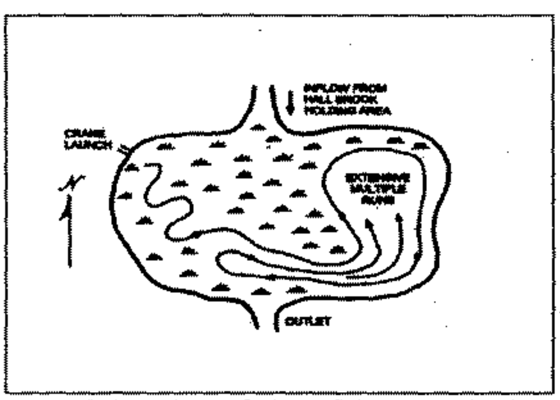


Figure 3. Locations of electrofishing runs in Halls Brook Holding Area Pond No. 3, Industri-Plex Site, Woburn, MA.

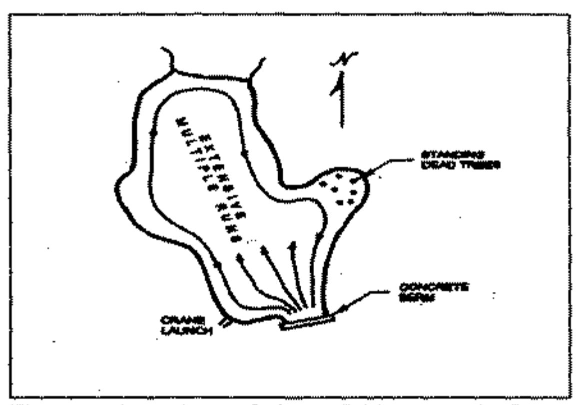


Figure 4. Locations of electrofishing runs in South Pond, Industri-Plex Site, Woburn, MA.

A number of indices are used to examine the condition and population structure of largemouth bass. In addition, a shoreline development index is discussed with respect to potential for aquatic productivity in the comparison among ponds.

Relative weight (W_r), a measure of condition or plumpness of an individual fish, was calculated for largemouth bass (*Micropterus salmoides*) captured in each of the ponds at the Site. To characterize the bass populations in the ponds the relative weights of bass from a data set of selected New Hampshire ponds (Sprankle 1997) were compared to the relative weights of bass found in the ponds at the Site. The relative weight measure is considered a more refined index of condition than other condition factors because of its convenience for comparison between populations. Relative weight compares the actual weight (W) of an individual fish with a standard weight (W_s) for a fish of the same length by the following association shown in the equation (Wege and Anderson, 1978):

$$W_r = W/W_s \bullet 100$$

The standard weight equation used for largemouth bass was:

$$\log_{10} W_s(g) = -5.316 + 3.191 \bullet \log_{10} TL(mm)$$

In addition, the established minimum length of 150mm was used to calculate W_r due to the great variability of weight measurements for small fish. High values of W_r may suggest or indicate an imbalance in the population, and low values can be related to high rates of mortality (Anderson and Neumann 1996). Fishery managers have established that a mean relative weight of 100 for a broad range of fish length groups represents ecological and physiological balance within a study population.

A t-test was conducted to determine whether the relative weight for the largemouth bass population in Halls Brook Holding Area was significantly different from the population in Phillips Pond. Both sample sizes were small and only a comparison in the Stock (200-299mm) category was possible.

Proportional Stock Density (PSD) and Relative Stock Density (RSD) quantify length-frequency structure of the harvestable population of a particular fish species (Anderson and Neumann, 1996). PSD is calculated by the following equation:

$$PSD = \frac{\text{number of fish} \geq \text{minimum quality length}}{\text{number of fish} \geq \text{minimum stock length}} \bullet 100$$

Although values of PSD range from 0 to 100, generally accepted stock density ranges for balanced largemouth bass populations are within 40 to 70 percent (Gablehouse 1984).

RSD is the percentage of fish of any designated length group in a sample, and is calculated by the following equation:

$$RSD = \frac{\text{number of fish} \geq \text{specified length}}{\text{number of fish} \geq \text{minimum stock length}} \bullet 100$$

PSD and RSD analyses were conducted for all four bass populations at the Site using length increments of Stock (200-299mm), Quality (300-379mm), Preferred (380-509mm), Memorable (510-629mm), and Trophy (≥630mm) as described in Gablehouse (1984). In addition, another category, Sub-stock (<200mm), was added to the analyses. The purpose for this addition was to show the number and condition of juvenile fish.

A balanced predator-prey relationship offers the potential for a fish population to maintain a state of equilibrium. Swingle (1950) as cited in Anderson and Neumann (1996) established a Y/C ratio where, the total weight of a fish small enough to be eaten by an average adult piscivorus fish (Y) is divided by the total weight of the adult-sized piscivorus fish group (C). The Y/C ratio for a balanced fish population is typically within a range of 1.0 to 3.0. This relationship was examined for prey fish defined as any fish <150mm in length (Hambright 1991, Jacobs and O'Donnell 1996) and available to largemouth bass. The predator was defined as any largemouth bass ≥200mm long.

Shoreline Development (D_l) is a morphometric parameter that reflects the potential for development of littoral communities. It is calculated by the following equation:

$$D_l = SL / 2(p\ A_0)^{1/2} ;$$

where SL is the shoreline and A_0 is the surface area of the waterbody.

As the length of the shoreline becomes more irregular, D_l deviates more from its minimum value of 1 which represents a perfect circle (Wetzel and Likens, 1990). The development of the littoral zone is briefly discussed with respect to its relationship to fish abundance in the ponds at the Site.

DISCUSSION AND RESULTS

A total of eight fish species was observed in ponds during sampling at the Industri-Plex Site (Figures 5-8). The eight fish species observed included: American eel, bluegill, brown bullhead, carp, golden shiner, largemouth bass, pumpkinseed, white sucker. All eight species were represented in Phillips Pond, while South Pond supported the least number of species. Eight carp were observed in HBHA Pond and one in Phillips Pond although these fish were not captured and not included in charts and tables. Tables 1-4 provide abundance and descriptive statistics for fish captured in each of the ponds. Among the most common species found in all four ponds were golden shiner (*Notemigonus crysoleucas*) and pumpkinseed (*Lepomis gibbosus*). Conversely, American eel (*Anguilla rostrata*) and bluegill (*Lepomis machrochirus*) were only found in Phillips Pond. White sucker and golden shiner were the most abundant species in HBHA Pond and Phillips Pond. Largemouth bass was the only piscivorus species present in all four ponds in moderate numbers. However, there was a greater abundance of largemouth bass in Phillips Pond (f/min) than in HBHA Pond (f/min). In general, both ponds had similar species composition, however sunfish species and bass were about three times more abundant in Phillips Pond than in HBHA Pond (Figures 5 and 6; Appendices A and B). The similarity of fish species diversity in the two ponds is evident in Table 5 by noting species captured, and CPUE statistics show similar trends in the magnitude of abundance of species in each pond.

No gross external abnormalities were observed on fish captured in any of the ponds. In HBHA Pond a pelvic fin was missing from one bullhead, and a dorsal fin was eroded on one largemouth bass. In

HBHA Pond No. 3 it was observed that the upper portion of the caudal fin on one white sucker was eroded or removed, and in Phillips Pond a pelvic fin was missing on one white sucker. These abrasions or injuries were not considered to be unusual and were likely the result of fungus found in wild fish populations, predator-prey interactions, or injury due to capture and handling.

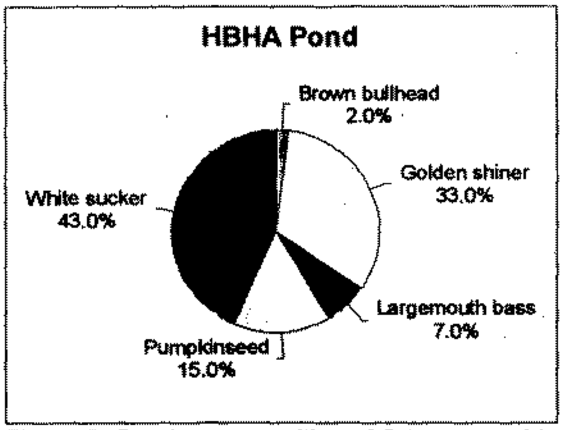


Figure 5. Species composition of fish captured in Halls Brook Holding Area Pond, Industri-Plex Site, Woburn, MA.

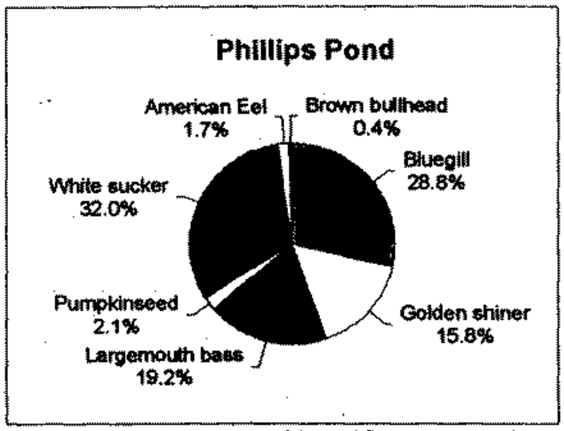


Figure 6. Species composition of fish captured from Phillips Pond, Industri-Plex Site, Woburn, MA.

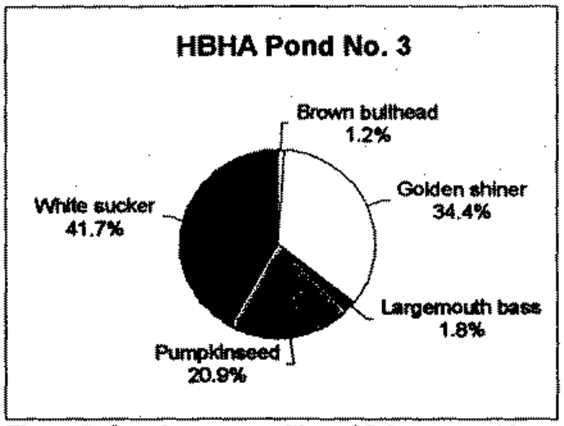


Figure 7. Species composition of fish captured from Halls Brook Holding Area Pond No. 3, Industri-Plex Site, Woburn, MA.

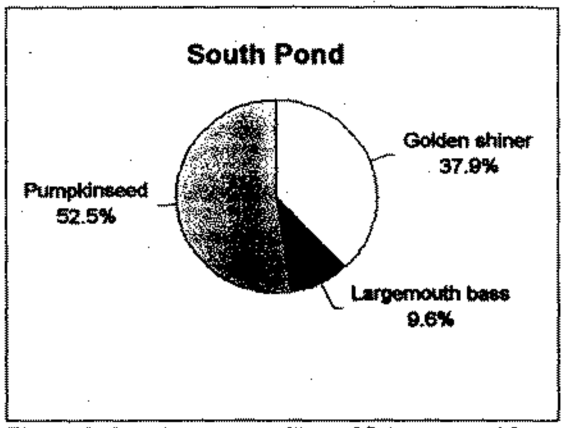


Figure 8. Species composition of fish captured from South Pond, Industri-Plex Site, Woburn, MA.

Table 1. Length statistics for fish captured in Halls Brook Holding Area Pond, Industri-Plex Site, Woburn, MA, June 1999.

Species	n	Total Length (mm)			
		Mean	Standard Deviation	Minimum	Maximum
Brown bullhead	3	301	57.5	242	357
Golden shiner	43	114	15.4	82	158
Largemouth bass	9	238	33.2	192	286
Pumpkinseed	20	93	22.1	48	127
White sucker	57	246	45.5	152	435

Table 2. Length statistics for fish captured in Philips Pond, Industri-Plex Site, Woburn, MA, June 1999.

Species	n	Total Length (mm)			
		Mean	Standard Deviation	Minimum	Maximum
American eel	4	602	5.3	596	606
Bluegill	69	141	18.9	84	176
Golden shiner	18	200	18.7	156	231
Largemouth bass	46	235	99.9	27	461
Pumpkinseed	5	107	14.3	87	124
White sucker	77	293	49.5	136	403
Brown bullhead	1	258	--	258	258

Table 3. Length statistics for fish captured in Halls Brook Holding Area Pond No. 3, Industri-Plex Site, Woburn, MA, June 1999.

Species	n	Total Length (mm)			
		Mean	Standard Deviation	Minimum	Maximum
Brown bullhead	2	321	22.6	305	337
Golden shiner	56	126	16.4	100	162
Largemouth bass	3	144	23.1	120	166
Pumpkinseed	34	91	10.1	52	115
White sucker	68	220	63.4	130	387

Table 4. Length statistics for fish captured in South Pond, Industri-Plex Site, Woburn, MA, June 1999.

Species	n	Total Length (mm)			
		Mean	Standard Deviation	Minimum	Maximum
Golden shiner	75	125	17.2	90	194
Largemouth bass	19	164	85.4	34	340
Pumpkinseed	104	91	10.4	60	120

Capture data indicates that South Pond had the lowest fish diversity with approximately 50 % of the captured fish composed of pumpkinseed. Species composition in HBHA Pond No. 3 was similar to that of HBHA Pond. However, largemouth bass was considerably under represented in HBHA Pond No. 3, contributing to about 2 % of the total catch (Figures 5, 7 and 8; Appendices A, C and D).

Although the sampling scheme did not target a particular species, largemouth bass was identified as the primary species of interest because of its trophic level status or position in the food web, and its importance as a recreational game fish. In general, sample sizes were small for largemouth bass in all of the ponds, however attempts were made to examine the population structure of this species (Tables 1-4; Appendices A-D).

Seventy-seven largemouth bass were captured in the four ponds at the Site (Tables 1-4). Phillips Pond was the only pond where bass were observed in size categories from Sub-stock to the larger Preferred Stock (Table 6; Appendix B).

Table 5. Catch-per-unit-effort (CPUE) expressed as fish per minute (f/min) for the first 30 minutes of sampling in Halls Brook Holding Area Pond and Phillips Pond at the Industri-Plex Site - June 1999, Woburn, Massachusetts.

Species	Halls Brook Holding Area			Phillips Pond		
	N	CPUE (f/min)	%	N	CPUE (f/min)	%
Carp	8	0.27	4	1	0.03	0
Sunfish spp.	11	0.37	6	31	1.03	13
Brown bullhead	0	0.00	0	1	0.03	0
Golden shiner	59	1.97	32	34	1.13	14
Largemouth bass	7	0.23	4	23	0.77	9
White sucker	99	3.30	54	157	5.23	64
Total		6.13	100		8.23	100

Table 6. Calculated Relative Weight (W_r) values, and Proportional Stock Density (PSD) and Relative Stock Density (RSD) indices for bass in Halls Brook Holding Area Pond, Phillips Pond, HBHA Pond No. 3, and South Pond at the Industri-Plex Site - June 1999, Woburn, Massachusetts.

	Sub-Stock (mm) (150-199)			Stock (mm) (200-299)			Quality (mm) (300-379)			Preferred (mm) (380-509)			Memorable (mm) (510-629)			Trophy (mm) (630+)			PSD	RSD
Waterbody	N	WR	SD	N	WR	SD	N	WR	SD	N	WR	SD	N	WR	SD	N	WR	SD		(380)
HBHA	1	92.1	-	8	105.2	7.74	0	-	-	0	-	-	0	-	-	0	-	-	-	0
Phillips Pond	14	88.2	8.0	8	86.2	6.9	13	86.3	10.1	2	85.0	3.1	0	-	-	0	-	-	65	9
Pond Three	1	105.7	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	-	0
South Pond	1	96.4	-	7	96.5	9.23	1	109.5	-	0	-	-	0	-	-	0	-	-	14	0
Mean	17	89.9		23	96.6		14	87.9		2	85.0		0	-		0	-			
SD		8.5			11.1			11.5			3.1			-			-			

The sample sizes of bass in the remaining ponds were small, and represented size categories were generally restricted to Sub-stock and Stock. The lack of abundance of smaller bass in all but Phillips Pond could be due to a number of factors including less than optimal habitat conditions for various life stages of the species.

PSD and RSD values for the bass in ponds at the Site are contrasted with values for exploited and unexploited lakes, the Connecticut River in Connecticut, and ponds in New Hampshire. Stock structure indices (PSD and RSD) suggest that the bass population in Phillips Pond is the only population among the Site ponds that approaches a balanced state relative to size and age with a PSD of 65 and an RSD of 9 (Table 7; Appendix E). The low PSD value of 14 calculated for South Pond, describes a population with few fish in the larger size categories, a state similar to HBHA Pond and HBHA Pond No. 3 where sample sizes were too small to make inferences (Table 6; Appendix E). While sample sizes for all categories of bass in the Site ponds were low, the lack of abundance of juvenile fish in the Sub-stock category (<200mm) is evident when capture numbers for the Site ponds are compared to capture numbers for Connecticut and New Hampshire waters (Table 7).

PSD values for bass in all four ponds suggest that these ponds do not support reasonably balanced bass populations (Table 6). They lack the larger size categories of fish with no Memorable or Trophy size fish captured. The largest individuals were ascribed to the Preferred category (461mm) and were collected from Phillips Pond, the only pond where size categories suggest greater balance in the population (Appendices E and F).

Mean relative weight values in the Stock category for HBHA Pond, Phillips Pond and South Pond were 105.2, 86.2 and 98.5 values, respectively (Table 8). Inferences are limited from these results. A relative weight value was not calculated for HBHA Pond No. 3 due to a small sample size. Mean relative weight comparisons for the Stock size category in HBHA Pond and Phillips Pond did not yield a significant difference ($\alpha = 0.05$). Mean relative weight values for selected ponds in New Hampshire are tabulated in Table 8. It is recognized that with the exception of Mass Cove on the Connecticut River, the waterbodies used for comparison are significantly larger than the ponds at the Site. However, values for the ponds presented were the only data found to be available. Although statistical tests were not performed, mean relative weight values for Site ponds appear to be within ranges similar to those for New Hampshire ponds, but sample sizes for the Site ponds are known to be small.

Table 7. Proportional Stock Density (PSD) and Relative Stock Density (RSD) indices for bass in Industri-Plex Site ponds (Massachusetts) and ponds located in Connecticut and New Hampshire. Sampling dates, surface water area and trophic status of ponds are provided where known.

Waterbody	Sampling Date	Area (ha)	Trophic Status	PSD	RSD 380	Nos <200mm
Massachusetts						
Halls Brook Holding Area	Jun-99	1.9	Eutrophic	–	–	8
Phillips Pond	Jun-99	2.3	Eutrophic	65	9	23
Pond Three	Jun-99	0.6	Eutrophic	–	–	–
South Pond	Jun-99	0.5	Eutrophic	14	–	8
Connecticut						
Exploited Lakes						
Avery Pond	1988-1995	20.6	Eutrophic	59	26	49
Bigelow Pond	1988-1995	7.7	Oligo-Mesotrophic	30	17	30
Mohawk Pond	1988-1995	6.1	Oligo-Mesotrophic	33	33	9
West Side Pond	1988-1995	17	Mesotrophic	17	7	46
Unexploited Lakes						
Maltby Lake No. 2	1988-1995	9.3	–	89	59	89
Maltby Lake No. 3	1988-1995	10.5	–	61	10	80
Connecticut River						
Mass Cove	1988-1995	2.6	–	28	6	334
Wethersfield Cove	1988-1995	14.6	–	42	7	45
Chapmans Pond	1988-1995	19.8	–	73	30	56
New Hampshire						
Burns Pond	Sep-97	47.4	Mesotrophic	55	8	52
Cedar Pond	Sep-97	32.4	Mesotrophic	77	53	17
Martin Meadow Pond	Sep-97	52.0	Mesotrophic	27	2	74
Nay Pond	Sep-97	22.7	Mesotrophic	7	7	14
Turtletown Pond	Jul-Sep-97	62.5	Eutrophic	85	9	79
Cunningham Pond	Aug-Sep-97	13.9	Oligotrophic	13	73	15

Table 8. Calculated mean relative weight (W_r) values and standard deviation (SD) for largemouth bass in Halls Brook Holding Area Pond, Phillips Pond, Halls Brook Holding Area Pond No. 3, and South Pond at the Industri-Plex Site - June 1999, and selected New Hampshire ponds where bass populations were assessed in 1997.

			Sub-Stock		Stock		Quality	
Waterbody	Area (ha))	Trophic Status	W_r	SD	W_r	SD	W_r	SD
HBHA, MA	1.9	Eutrophic	92.1	–	105.2	7.7	–	–
Phillips Pond, MA	2.3	Eutrophic	88.2	8.0	86.2	6.9	86.3	10.1
Pond Three, MA	0.6	Eutrophic	105.7	–	–	–	–	–
South Pond, MA	0.5	Eutrophic	96.4	–	98.5	9.2	109.5	–
Burns Pond, NH	47.8	Mesotrophic	–	–	102.3	7.4	98.1	5.0
Cedar Pond, NH	31.6	Mesotrophic	–	–	109.7	4.8	100.9	6.5
Martin Meadow Pond, NH	47.8	Mesotrophic	–	–	99.5	6.1	98.2	6.0
Nay Pond, NH	22.7	Mesotrophic	–	–	113.3	5.1	123.2	–
Turtletown Pond, NH	49.0	Eutrophic	–	–	95.	12.3	88.0	7.6
Cunningham Pond, NH	15.4	Oligotrophic	–	–	102.1	12.4	97.0	4.8

Predator/prey (Y/C) ratios were calculated for HBHA Pond and Phillips Pond to examine the structural characteristics of predators and prey in these ponds with respect to fish species interactions. The Y/C ratios for the ponds were not greatly different, where the ratio was calculated as 0.19 for Phillips Pond, and 0.60 for HBHA Pond (Table 9). A value between 1.0 and 3.0 represents a balanced population where enough forage is present to adequately sustain the population. The ratio for Phillips Pond may be underestimated. Stock structure indices for this pond suggest a relatively balanced population PSD (65) and RSD (9). It is possible that smaller forage fish were in greater abundance in the littoral zone in Phillips Pond. Beaver activity in Phillips Pond had raised the pond water level an estimated two feet at the time of sampling. The resultant flooding had likely increased the area in the littoral zone and perhaps boat electrofishing was not as efficient in this near shore zone. In HBHA Pond, observations indicated a lack of aquatic vegetation and cover in a large portion of the littoral zone. Juvenile bass and other fish species use structure and vegetation as escape cover from larger fish. An absence of such features could result in an increase in predation on juvenile life stages.

In HBHA Pond No. 3 and South Pond aquatic vegetation was abundant, pond area was relatively small, maximum depth was less than 3.0m, substrate was characterized as muddy, and sand and gravel areas suitable for spawning bass were limited. While vegetation in the ponds was abundant and offered cover for small fish, the production potential of the ponds, particularly for bass, may be limited. The ponds are small in size and shallow, factors that may limit balanced fish stock abundance. In addition, there appeared to be a paucity of suitable spawning habitat for bass in these ponds. Of note also is the fact that a regional weather/climatic event may have altered physical features of HBHA Pond, HBHA Pond No. 3 and South Pond with respect to water levels and water temperature. At the time of this survey drought conditions had persisted across the State of Massachusetts. The surface water table was extremely low, particularly for HBHA Pond No. 3 and South Pond. Such conditions may have negatively affected aquatic habitat and abundance of fish in the ponds. Stock structure indices for both HBHA Pond No. 3 and South Pond may also have been affected by minor sample bias. Some small fish of all species, though observed, were not captured in these ponds. It is possible that a few small ($\approx$150mm) bass were misrepresented as other species and thus overlooked or not captured due to the directed effort at capturing larger fish (>150mm) to ensure adequate tissue samples for laboratory analyses. As previously stated, an abundance of vegetation in South Pond, and shallow water in HBHA Pond No. 3 limited boat operations in these ponds. These factors precluded the completion of systematic timed runs in the ponds, and the measure of relative abundance expressed as CPUE. Figures 1-4 depicting species composition were determined based on the total of timed runs in HBHA Pond [3 runs @ 10 min/run = 30 min] and Phillips Pond [3 runs @ 10 min/run = 30 min], and total time fished in HBHA Pond No. 3 [multiple runs = 30 min] and South Pond [multiple runs = 85 min].

Table 9. Predator / Prey (Y/C) ratios, total weight of prey (<150mm total length) species, and total weight of predators (largemouth bass >200mm total length) for Halls Brook Holding Area Pond and Phillips Pond at the Industri-Plex Site - June 1999.

Pond	Prey (g)	Predator (g)	Y/C
HBHA Pond	1049	1753	0.60
Phillips Pond	2135.5	11075	0.19

The warm, weedy waters of lakes and ponds typically provide good habitat for largemouth bass. Bass require extensive shallow areas with submerged vegetation that provides optimal growth conditions, and deep water that provides good overwinter habitat. Generally, ponds with vegetation/cover over 40-60% of the area are preferred by largemouth bass (Stuber et.al. 1982). Too much vegetation/cover can decrease habitat suitability for bass (Saiki and Tash 1979). Juvenile bass feed on insect larvae, plankton and small crustaceans. As they grow larger their diet shifts to one comprised more of fish and crayfish, and other opportunistic and less common items such as frogs, mussels and snails.

Largemouth bass reach sexual maturity at 2-3 years of age. At maturity, males will construct nests in shallow waters (0.3-0.9 m) where they will lure females to spawn. Nest construction begins in the spring when water temperatures reach approximately 15°C and spawning occurs at about 18°C. Males guard the nest during egg incubation and for a short while after fry emergence. Fluctuations in water level during and after the spawning period can result in mortality of egg and emergent fry life stages. Increases in turbidity during and post spawning can also adversely affect eggs and fry. If the HBHA Pond functions as a retention basin then water levels may fluctuate in spring due to runoff from snow melt and storm events, and increased impermeability around the site. Frequent events may also result in water fluctuations that reduce prey availability for juvenile and adult bass life stages.

Largemouth bass as well as sunfish typically select shallow protected spawning sites in coves and bays with ample emergent vegetation that may include reeds, bullrushes, water lilies and pond weed. Cover dependant bass and sunfish show an affinity for floating objects such as vegetation, debris, and structure. These species are generally found in association with muddy bottoms, sand and gravel spawning areas, structure including brush, stumps, rocks and boulders, and a variety of emergent and subemergent vegetation. Optimal bass habitat is also associated with irregular shorelines and water depths.

The extent of development of the littoral zone within a waterbody can vary greatly, and an irregular shoreline can result in an increase in abundance and diversity of vegetation. Abundant vegetation increases productivity and provides not only food resources but habitat to a diverse array of organisms including phytoplankton, zooplankton, invertebrates and fish. Although Shoreline Development was not calculated for the Industri-Plex Site ponds, observations suggest that HBHA Pond is likely to have a D_l closer to 1 and therefore lower potential for littoral development. In contrast, the physical characteristics of Phillips Pond suggests greater potential for littoral development. These characteristics could result in increased productivity and greater potential for enhanced growth rates of the various fish species, including bass, that inhabit the pond.

For waterbodies in northern latitudes, optimal overwinter bass habitat must be at least 5.5m in depth for about 40 to 60 % of the pond area (Stuber et al. 1982). Pond area greater than 5.5m in depth is not likely within the 40 to 60 % range for each of the Site ponds with the exception of Phillips Pond. HBHA Pond has a maximum depth of about 4.3m, while Phillips Pond has an approximate maximum depth of 6.1m. South Pond and HBHA Pond No. 3 are very shallow ponds with maximum depths that are less than 3.0m, a characteristic that provides little if any overwinter habitat.

Largemouth bass growth is reduced at dissolved oxygen levels less than 8.0 mg/l, distress may be visible at 5 mg/l, and lethal levels of 1.5 mg/l and lower are avoided by fish (Stewart et al. 1967; Scott and Crossman 1973). Dissolved oxygen levels in HBHA Pond at mid-depth for deeper water sites averaged about 7.5 mg/l in March and November 1998, and average summer levels have been recorded at 4.5 mg/l (Le May, 1998 and 1999). Near bottom dissolved oxygen levels at these sites have approached or exceeded lethal levels in fall. Low dissolved oxygen levels and anoxic conditions in shallow and deep water during summer and fall could increase mortality and adversely affect growth rates of bass and other fish species, resulting in altered fish population structures and a decrease in fish species abundance. Winter mortality or die-off may also occur during ice cover periods if the biological oxygen demand is high due to decaying organic matter.

Given the size of bass observed in the ponds, the potential for harvesting fish in a recreational fishery is limited. The legal length limit for retention of largemouth bass in Massachusetts is 305mm (12 inches). Bass of this length were only observed in Phillips and South ponds. The number and size of bass observed in HBHA Pond limits the potential for recreational angling opportunities. In addition, the observed fish species assemblage in the pond does not offer desirable opportunities for recreational angling.

SUMMARY AND CONCLUSIONS

This fishery survey was conducted in part to examine fish species composition and relative abundance of species found in four ponds at the Industri-Plex Site. It was intended that fish species diversity and composition in HBHA Pond and HBHA Pond No. 3 be compared with two reference ponds identified as Phillips Pond and South Pond, respectively. Given its trophic level status or position in the food web, as well as its importance to recreational anglers, largemouth bass was identified as a particular species of interest. As such, a number of indices were used to examine the general condition and structure of the bass populations found in the ponds.

In aggregate, eight fish species were found in the four ponds. No gross external abnormalities were observed on fish captured in the ponds. Abrasions or injuries found on fish were likely the result of fungus found in wild fish populations, predator-prey interactions, or injury due to capture and handling.

Species diversity was greatest in Phillips Pond where all species were observed, but in South Pond, diversity was low with only three species noted. Largemouth bass, golden shiner, and pumpkinseed were observed in all four ponds, whereas American eel and bluegill were found only in Phillips Pond. Species composition in HBHA Pond No. 3 was similar to that of HBHA Pond, however bass were considerably under represented in HBHA Pond No. 3. Only in Phillips Pond were bass observed in a broad range of size categories. Also, relative abundance of bass within size categories in this pond was greater than in all other ponds. Stock structure indices for bass in Phillips Pond suggest a more balanced population relative to size and age than that observed in other ponds. However, no bass in the larger size categories of Memorable (510-629 mm) and Trophy ($\geq$630 mm) were observed in Phillips Pond. Bass were not a dominant species found in the other ponds, and the sample size of bass in all size categories in these ponds was quite low. Size categories in these ponds were generally restricted to < 150 mm, Sub-stock (150-199 mm) and Stock (200-299 mm).

Observations indicated a lack of aquatic vegetation and cover in the littoral zone and throughout HBHA Pond, features that may result in an increase in predation on juvenile life stages of bass and other species. In addition, water quality data available for HBHA Pond suggests that periodic low dissolved oxygen levels and anoxic conditions could adversely affect survival and growth of bass and other species resulting in altered fish population structures and a decrease in fish species abundance.

While aquatic vegetation in HBHA Pond No. 3 and South Pond was abundant, pond area was small, maximum water depth was less than 3.0 m, and sand and gravel areas suitable for spawning bass were limited. These features may limit bass stock abundance, but still offer suitable rearing habitat for generally smaller species such as golden shiner, and species such as bullhead and white sucker that are more tolerant of warm, weedy, shallow ponds or lakes. The physical characteristics of Phillips

Pond including a well developed littoral zone offering structure and vegetation for cover, protection, and prey item production, as well as deep water for overwinter habitat were more diverse than observed in other ponds. Of all the ponds, this pond offers the greatest potential for a recreational fishery. The remaining three ponds offer poor habitat for recreational fish species, and given the size structure of bass observed in the ponds, the potential for harvesting this species in a recreational fishery is quite limited.

REFERENCES

Anderson, R.O. and R.M. Neumann. 1996. Length, weight, and associated structural indices. Pages 447-482 in B.R. Murphy and D.W. Willis, editors. Fisheries techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Gablehouse, D.W. 1984. A length categorization system to assess fish stocks. North American Journal of Fisheries Management 4: 273-285.

Hambright, K.D. 1991. Experimental analysis of prey selection by largemouth bass: role of predator mouth width and prey body depth. Transactions of the American Fisheries Society 120: 500-508.

Jacobs, R. and E.B. O'Donnell. 1996. An electrofishing survey of selected Connecticut lakes. Statewide Largemouth Bass Research and Management Final Report. F-57-R-14. Department of Environmental, Protection Bureau of Natural Resources, Fisheries Division. 190 pp.

Le May, J. 1998, 1999. Industri-Plex: Surface Water Quality Sampling Results from HBHA and Aberjona River. U.S. Environmental Protection Agency, Boston, Massachusetts.

Menzie-Cura & Associates, Inc. 1999. Toxicological surface water, sediments sampling and fish sampling work plan, and quality assurance project plan for the Industri-Plex Site, Woburn, Massachusetts. Chelmsford, Massachusetts.

Saiki, M. K., and J. C. Tash. 1979. Use of cover and dispersal by crayfish to reduce predation by largemouth bass. Pages 44-48. In D. L. Johnson and R. A. Stein, eds. Response of fish to habitat structure in standing water. N. Central Div. Am. Fish. Soc. Spec. Publ. 6.

Scott, W.B., and E.J. Crossman. 1973. Freshwater fishes of Canada. Fish. Res. Board Can. Bull 184. pp. 734-740.

Sprankle K. 1997. Black bass population assessments in selected New Hampshire waters. New Hampshire's Inland Fisheries Operational Management Plans. Grant: F-50-R. 30 pp.

Stewart, N.E., D.L. Shumway, and P. Doudoroff. 1967. Influence of oxygen concentration on the growth of juvenile largemouth bass. J. Fish. Res. Board Can. 24: 475-494.

Stuber, R.J., G. Gebhart and O.E. Maughan. 1982. Habitat suitability index models: Largemouth bass. U.S. Dept. Int. Fish Wildl. Serv. FWS/OBS-82/10.16. 32 pp.

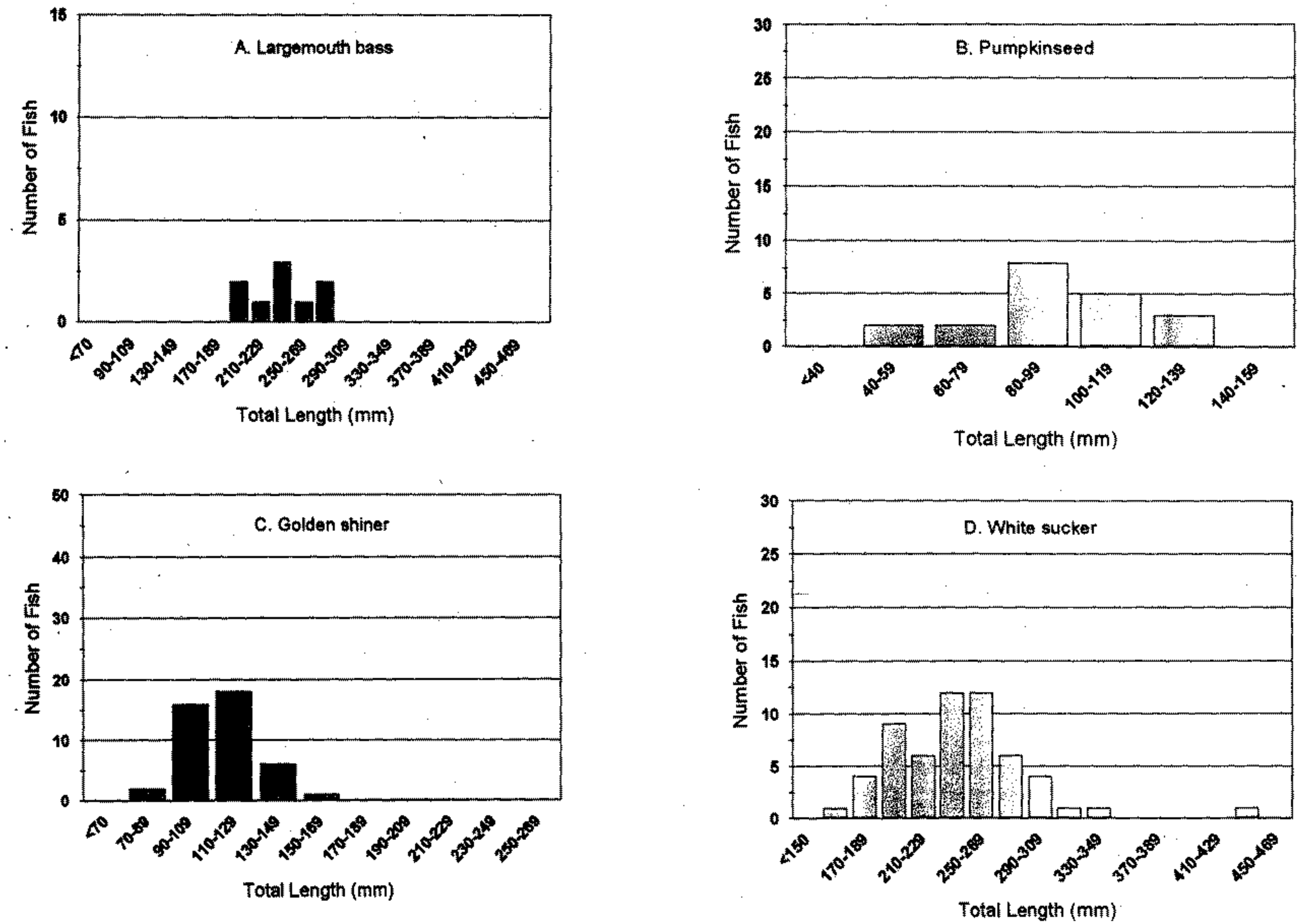
Swingle 1950. Relationships and dynamics of balanced and unbalanced fish populations. Alabama Agricultural Experiment Station, Auburn University, Bulletin 274.

Wege, G.J. and R.O. Anderson. 1978. Relative Weight (W_r): a new index of condition for largemouth bass. Pages 79-91 in G.D. Novinger and J. G. Gillard, editors. New approaches to the management of small impoundments. American Fisheries Society, North Central Division, Special Publication 5, Bethesda, Maryland.

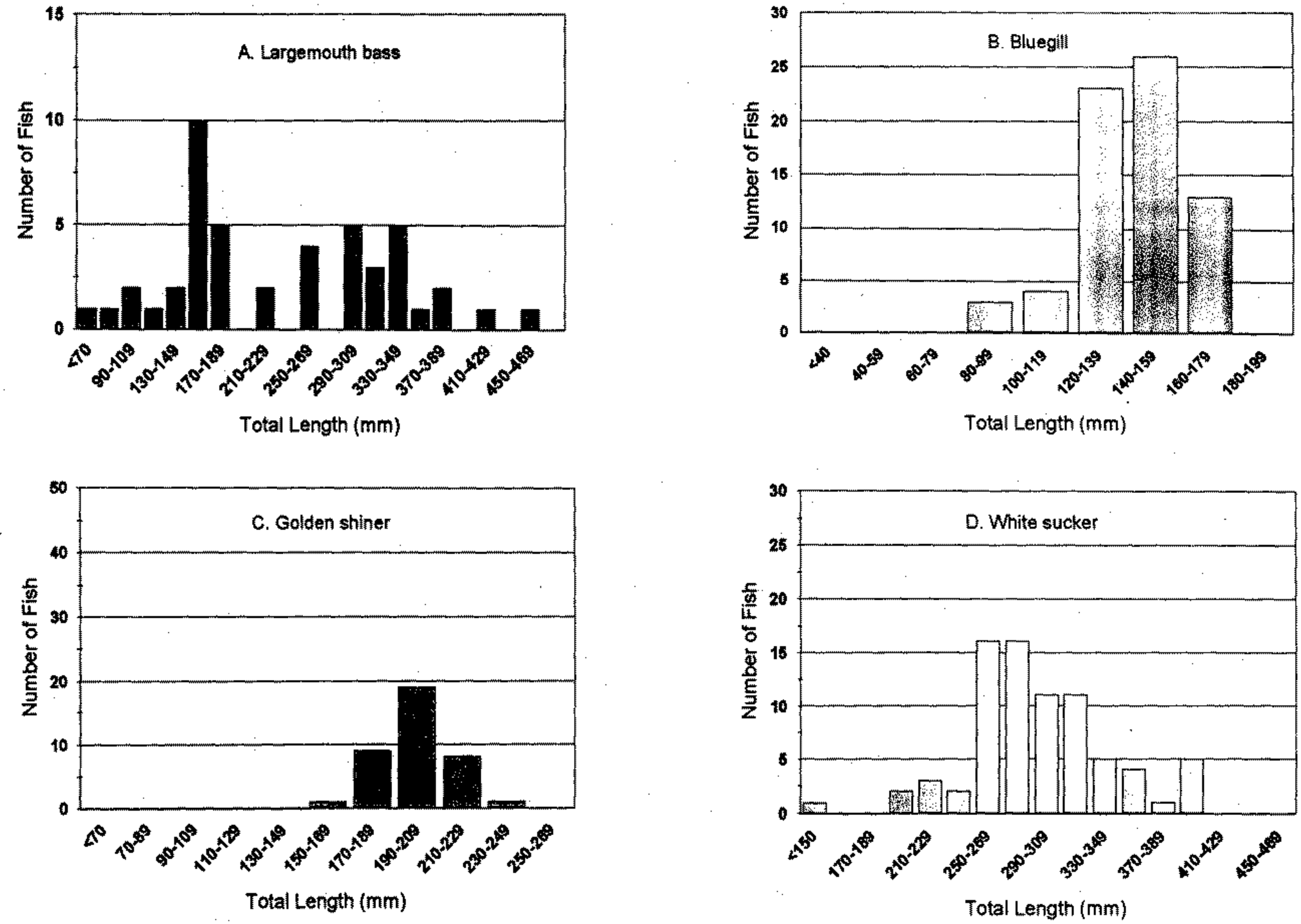
Wege, G.J. and R.O. Anderson. 1979. Influence of artificial structure on largemouth bass and bluegills in small ponds. Pages 59-69 in D.L. Johnson and R.A. Stein, editors. Response of fish to habitat structures in standing water. North Central Division, American Fisheries Society, Special Publication 6 *cited in* Uberuaga, R. and L Bizios. 1991. Arizona warmwater fisheries enhancement: the Saguaro Lake project. Warmwater Fisheries Symposium I. USDA Forest Service. General technical report RM-207, 57-61.

Wetzel, R.G. and G.E. Likens. 1990. Limnological Analyses. Springer-Verlag. New York. 391 pp.

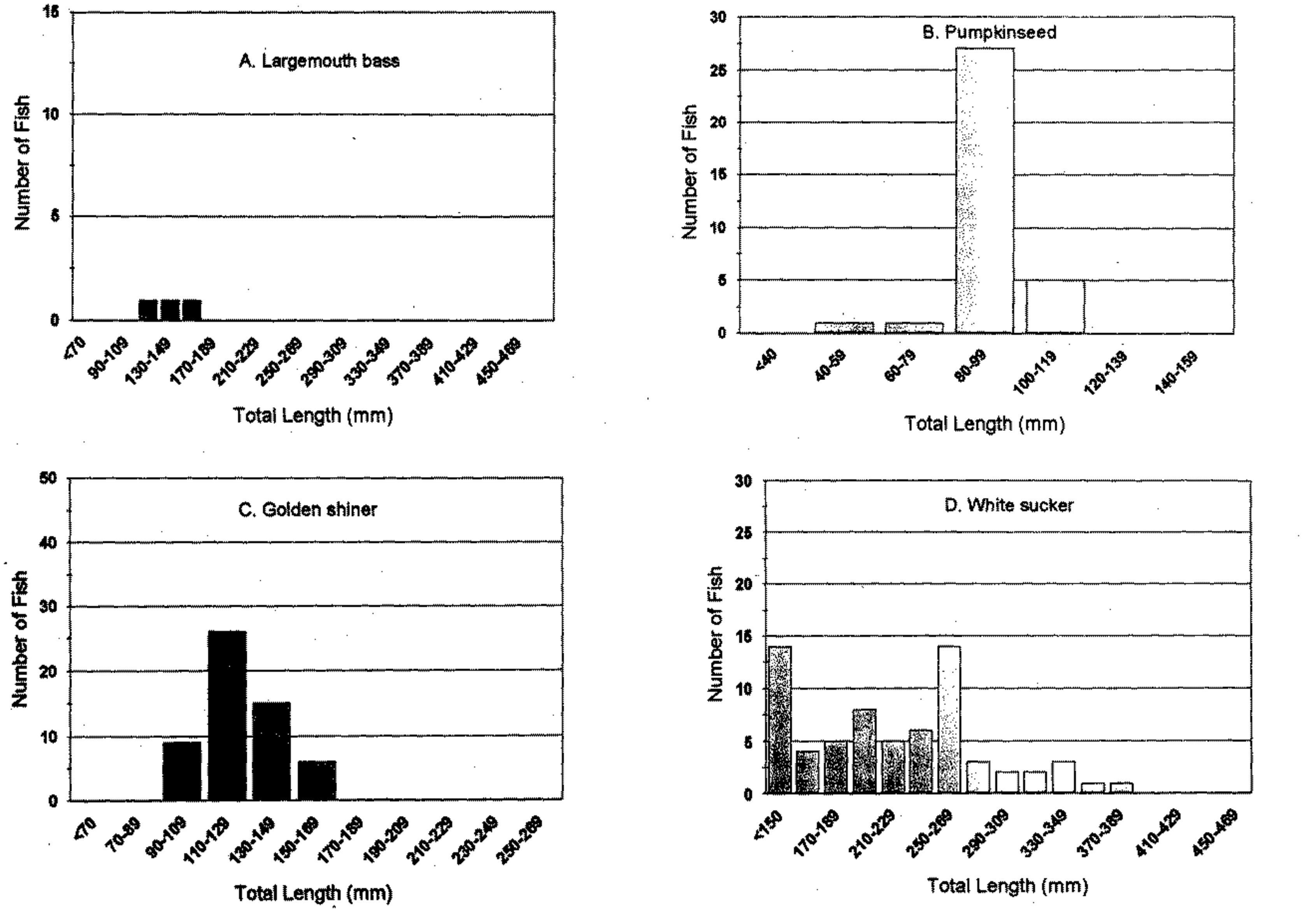
Appendices



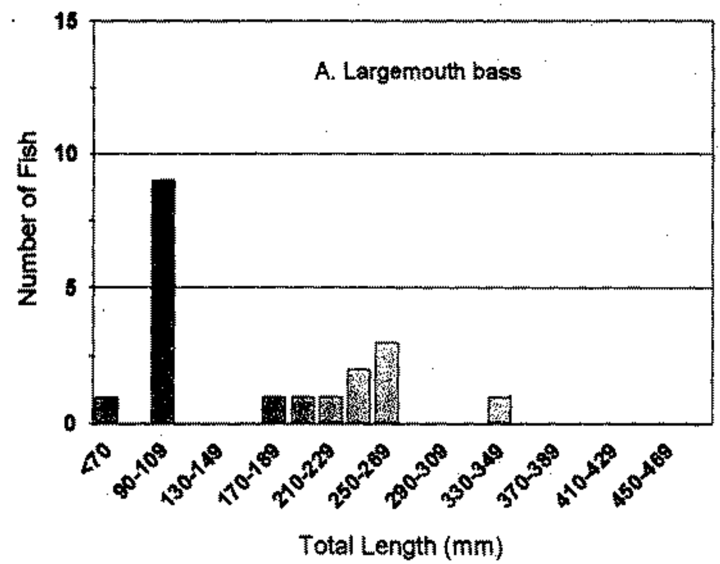
Appendix A. Length frequency distributions for Largemouth bass (A), Pumpkinseed (B), Golden shiner (C), and White sucker (D) in Halls Brook Holding Area Pond at the Industri-Plex Site, Woburn, Massachusetts, June 1999.

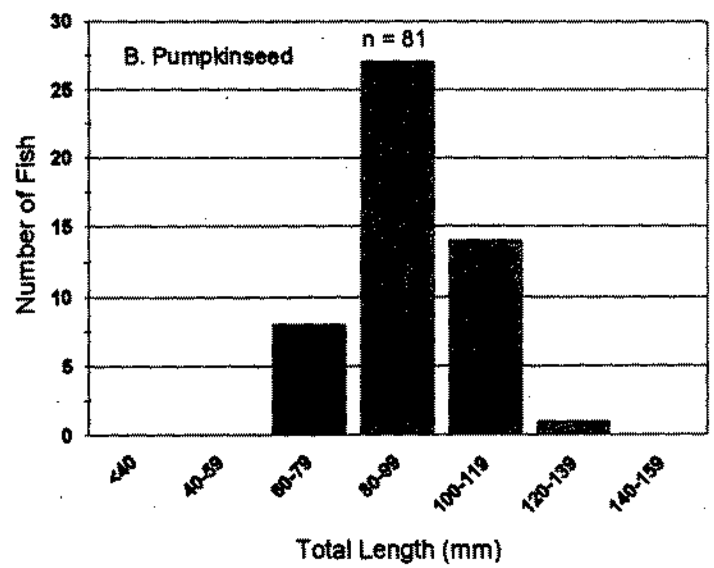


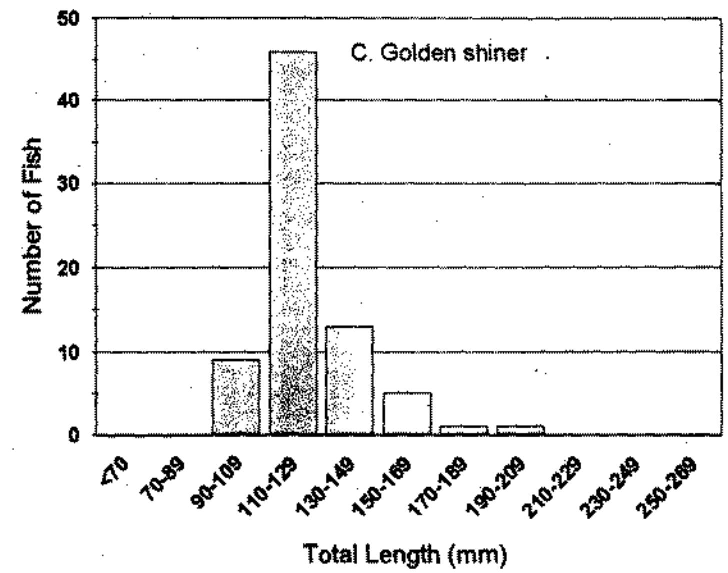
Appendix B. Length frequency distributions for Largemouth bass (A), Bluegill (B), Golden shiner (C), and White sucker (D) in Phillips Pond at the Industri-Plex Site, Woburn, Massachusetts, June 1999.



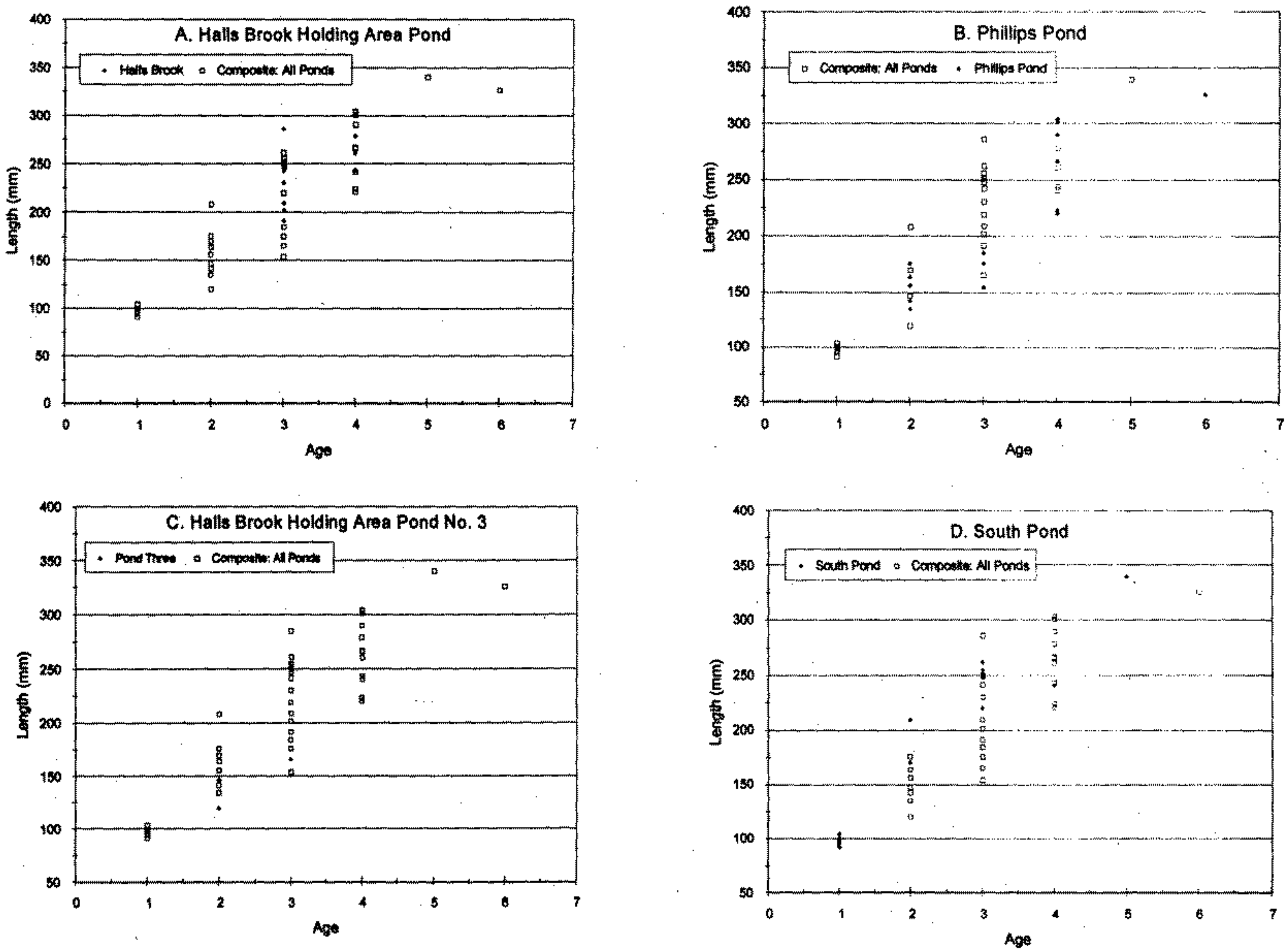
Appendix C. Length frequency distributions for Largemouth bass (A), Pumpkinseed (B), Golden shiner (C), and White sucker (D) in Halls Brook Holding Area Pond No. 3 at the Industri-Plex Site, Woburn, Massachusetts, June 1999.



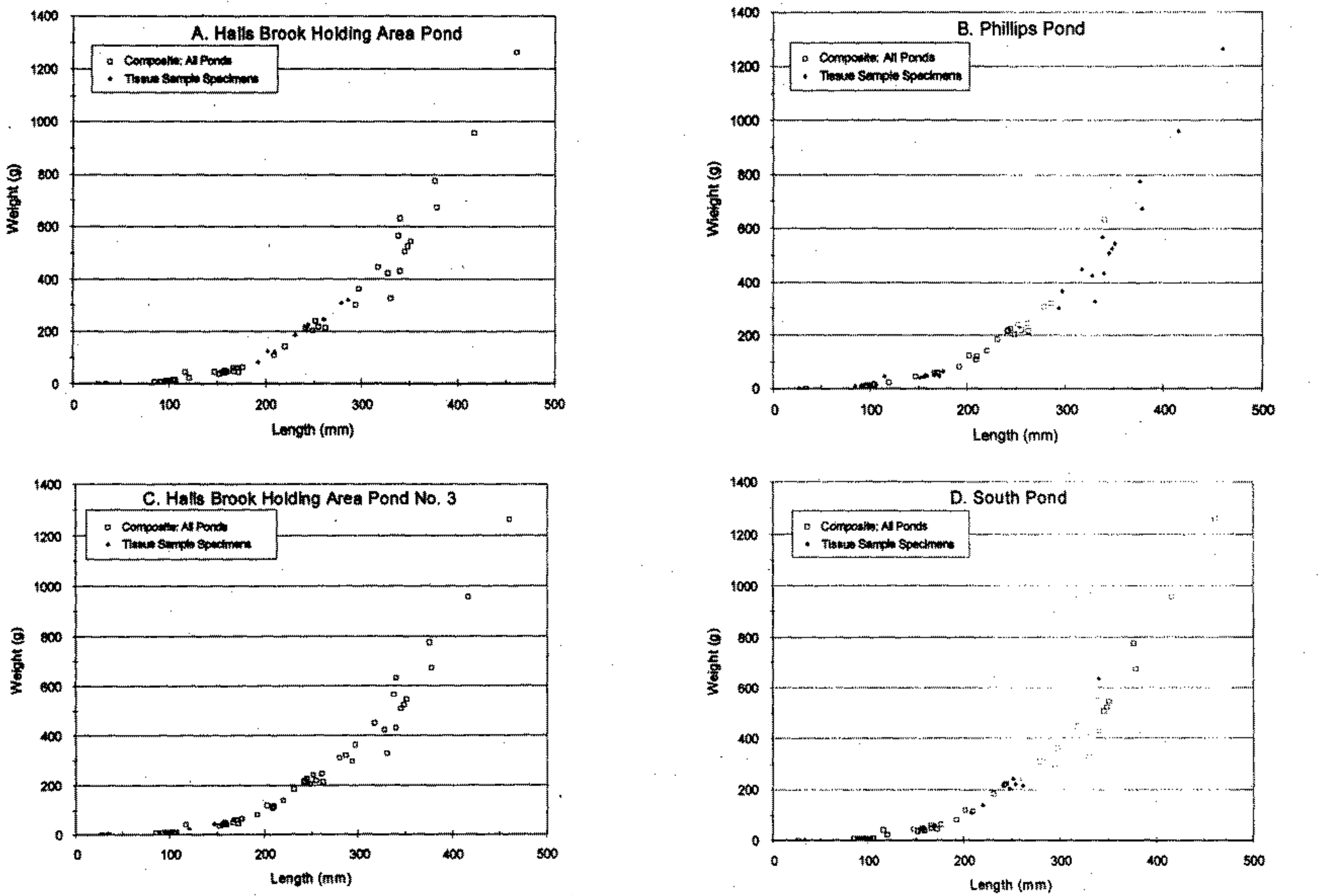




Appendix D. Length frequency distributions of Largemouth bass (A), Pumpkinseed (B), and Golden shiner (C) in South Pond at the Industri-Plex Site, Woburn Massachusetts, June 1999.



Appendix E. Composite Length - Age relationships for Largemouth bass showing captures for Halls Brook Holding Area Pond (A), Phillips Pond (B), Halls Brook Holding Area Pond No. 3 (C), and South Pond (D) at the Industri-Plex Site, Woburn, Massachusetts, June 1999.



Appendix F. Total Length (mm) - Weight (g) relationships for Largemouth bass in Halls Brook Holding Area Pond (A), Phillips Pond (B), Halls Brook Holding Area Pond No. 3 (C), and South Pond (D) at the Industriplex Site, Woburn, Massachusetts, June 1999.

Appendix G. List of sample sites and descriptive statistics for fish species captured in the Industri-Plex Site Ponds, Woburn, Massachusetts, June 1999.

Site	Species	Length (mm)	Weight (g)	Scales	Site	Species	Length (mm)	Weight (g)	Scales
HBHA	BB	242	224	BB2	HBHA	GS	158	49	
HBHA	BB	304	483	BB3	HBHA	LMB	192	86	LMB4
HBHA	BB	357	606	BB1	HBHA	LMB	202	124	LMB7
HBHA	GS	82	5		HBHA	LMB	210	120	LMB5
HBHA	GS	87	7		HBHA	LMB	231	187	LMB2
HBHA	GS	90	6	GS14	HBHA	LMB	242	219	LMB
HBHA	GS	98	10	GS2	HBHA	LMB	244	227	LMB3
HBHA	GS	100	9		HBHA	LMB	261	247	LMB9
HBHA	GS	101	12	GS20	HBHA	LMB	279	309	LMB8
HBHA	GS	102	12	GS10	HBHA	LMB	286	320	LMB1
HBHA	GS	103	10		HBHA	PSS	48	2	PSS10
HBHA	GS	104	10	GS6	HBHA	PSS	50	1	PSS18
HBHA	GS	104	10		HBHA	PSS	70	5	PSS17
HBHA	GS	104	12	GS1	HBHA	PSS	74	7	PSS12
HBHA	GS	105	13		HBHA	PSS	83	10	PSS13
HBHA	GS	106	11	GS5	HBHA	PSS	87	12	PSS
HBHA	GS	106	11		HBHA	PSS	88	13	PSS8
HBHA	GS	107	15	GS3	HBHA	PSS	89	12	PSS9
HBHA	GS	108	12	GS13	HBHA	PSS	91	13	PSS7
HBHA	GS	108	13		HBHA	PSS	91	14	PSS6
HBHA	GS	109	12	GS15	HBHA	PSS	92	13	PSS4
HBHA	GS	112	17		HBHA	PSS	96	16	PSS3
HBHA	GS	113	14	GS17	HBHA	PSS	100	17	PSS15
HBHA	GS	113	15		HBHA	PSS	102	19	PSS14
HBHA	GS	114	17		HBHA	PSS	105	21	PSS
HBHA	GS	116	16		HBHA	PSS	108	26	PSS2
HBHA	GS	116	17	GS12	HBHA	PSS	116	32	PSS1
HBHA	GS	116	17		HBHA	PSS	126	38	PSS16
HBHA	GS	117	16		HBHA	PSS	126	39	PSS5
HBHA	GS	117	16		HBHA	PSS	127	44	PSS11
HBHA	GS	117	17		HBHA	WS	152	34	
HBHA	GS	117	18	GS7	HBHA	WS	178	59	
HBHA	GS	118	17		HBHA	WS	184	67	
HBHA	GS	118	19	GS18	HBHA	WS	185	65	
HBHA	GS	119	17	GS19	HBHA	WS	188	67	
HBHA	GS	119	19		HBHA	WS	192	69	
HBHA	GS	123	19	GS16	HBHA	WS	196	71	
HBHA	GS	123	20		HBHA	WS	198	74	
HBHA	GS	126	21		HBHA	WS	201	NA	
HBHA	GS	131	23	GS4	HBHA	WS	202	83	
HBHA	GS	136	31	GS9	HBHA	WS	203	83	
HBHA	GS	137	28		HBHA	WS	207	84	
HBHA	GS	139	36	GS11	HBHA	WS	207	93	
HBHA	GS	141	35		HBHA	WS	209	92	
HBHA	GS	147	40	GS8	HBHA	WS	218	96	

Appendix G (cont'd). List of sample sites and descriptive statistics for fish species captured in the Industri-Plex Site Ponds, Woburn, Massachusetts, June 1999.

Site	Species	Length (mm)	Weight (g)	Scales	Site	Species	Length (mm)	Weight (g)	Scales
HBHA	WS	222	108		Philips	BG	84	10	
HBHA	WS	224	112		Philips	BG	94	13	
HBHA	WS	225	112		Philips	BG	97	17	BG21
HBHA	WS	227	119		Philips	BG	110	25	
HBHA	WS	229	118		Philips	BG	110	27	BG22
HBHA	WS	231	125		Philips	BG	112	22	BG1
HBHA	WS	231	133		Philips	BG	117	29	BG19
HBHA	WS	236	131		Philips	BG	122	32	BG7
HBHA	WS	236	139		Philips	BG	122	36	BG6
HBHA	WS	239	135		Philips	BG	124	39	
HBHA	WS	241	144		Philips	BG	125	37	
HBHA	WS	243	128		Philips	BG	125	38	
HBHA	WS	245	146		Philips	BG	126	33	BG14
HBHA	WS	246	152		Philips	BG	126	38	BG20
HBHA	WS	247	150		Philips	BG	126	39	BG16
HBHA	WS	247	154		Philips	BG	128	37	
HBHA	WS	249	156		Philips	BG	128	43	BG17
HBHA	WS	252	148		Philips	BG	130	47	
HBHA	WS	255	156	WS3	Philips	BG	131	47	BG4
HBHA	WS	256	161		Philips	BG	132	38	BG2
HBHA	WS	256	163		Philips	BG	132	41	
HBHA	WS	257	168		Philips	BG	134	40	BG11
HBHA	WS	258	180		Philips	BG	134	45	
HBHA	WS	259	179		Philips	BG	136	43	BG8
HBHA	WS	260	173		Philips	BG	137	11	BG12
HBHA	WS	263	164		Philips	BG	137	41	BG15
HBHA	WS	266	190		Philips	BG	138	47	
HBHA	WS	267	207		Philips	BG	139	38	
HBHA	WS	268	179		Philips	BG	139	49	BG18
HBHA	WS	271	197		Philips	BG	139	56	
HBHA	WS	272	195		Philips	BG	140	46	
HBHA	WS	275	220		Philips	BG	141	43	BG13
HBHA	WS	276	208		Philips	BG	142	45	
HBHA	WS	280	218		Philips	BG	142	52	
HBHA	WS	282	212	WS2	Philips	BG	142	62	BG9
HBHA	WS	298	258	WS5	Philips	BG	143	49	BG10
HBHA	WS	301	288		Philips	BG	144	52	
HBHA	WS	303	253	WS6	Philips	BG	144	56	
HBHA	WS	307	303	WS8	Philips	BG	145	45	
HBHA	WS	322	320	WS4	Philips	BG	145	58	BG5
HBHA	WS	335	319	WS1	Philips	BG	146	55	
HBHA	WS	435	742	WS7	Philips	BG	146	NA	
Philips	AE	596	418		Philips	BG	147	67	
Philips	AE	604	427		Philips	BG	149	64	BG3
Philips	AE	606	457		Philips	BG	150	55	
Philips	AE	650	422		Philips	BG	150	61	
Philips	BB	258	265	BB1	Philips	BG	151	61	

Appendix G (cont'd). List of sample sites and descriptive statistics for fish species captured in the Industri-Plex Site Ponds, Woburn, Massachusetts, June 1999.

Site	Species	Length (mm)	Weight (g)	Scales	Site	Species	Length (mm)	Weight (g)	Scales
Philips	BG	154	58		Philips	GS16	187	69	
Philips	BG	154	61		Philips	GS17	204	105	
Philips	BG	155	65		Philips	GS18	181	75	
Philips	BG	156	61		Philips	GS19	209	140	
Philips	BG	157	66		Philips	GS2	180	75	
Philips	BG	157	68		Philips	GS20	206	99	
Philips	BG	157	76		Philips	GS3	206	120	
Philips	BG	159	67		Philips	GS4	199	96	
Philips	BG	159	75		Philips	GS5	206	96	
Philips	BG	160	70		Philips	GS6	183	70	
Philips	BG	160	75		Philips	GS7	180	76	
Philips	BG	161	70		Philips	GS8	206	104	
Philips	BG	161	78		Philips	GS9	193	88	
Philips	BG	162	67		Philips	LMB	27	0.5	LMB
Philips	BG	164	74		Philips	LMB	85	8	LMB
Philips	BG	165	82		Philips	LMB	91	11	LMB
Philips	BG	166	85		Philips	LMB	106	15	
Philips	BG	166	92		Philips	LMB	116	45	
Philips	BG	167	79		Philips	LMB	135	25	LMB10
Philips	BG	168	69		Philips	LMB	142	32	LMB16
Philips	BG	168	88		Philips	LMB	152	NA	
Philips	BG	176	98		Philips	LMB	154	39	LMB14
Philips	GS	156	46		Philips	LMB	155	44	LMB
Philips	GS	179	76		Philips	LMB	156	44	LMB8
Philips	GS	181	82		Philips	LMB	157	44	LMB
Philips	GS	183	70		Philips	LMB	157	50	
Philips	GS	185	81		Philips	LMB	159	45	
Philips	GS	192	96		Philips	LMB	164	47	LMB18
Philips	GS	197	95		Philips	LMB	166	49	
Philips	GS	198	103		Philips	LMB	166	60	LMB13
Philips	GS	200	85		Philips	LMB	172	47	LMB
Philips	GS	200	99		Philips	LMB	176	58	LMB12
Philips	GS	204	116		Philips	LMB	176	65	LMB
Philips	GS	209	134		Philips	LMB	181	67	LMB11
Philips	GS	212	112		Philips	LMB	185	70	LMB4
Philips	GS	214	117		Philips	LMB	221	112	LMB2
Philips	GS	215	122		Philips	LMB	224	145	LMB1
Philips	GS	218	157		Philips	LMB	250	175	LMB3
Philips	GS	226	149		Philips	LMB	250	593	LMB
Philips	GS	231	181		Philips	LMB	266	221	LMB9
Philips	GS1	197	107		Philips	LMB	267	228	LMB17
Philips	GS10	193	103		Philips	LMB	290	307	LMB15
Philips	GS11	222	146		Philips	LMB	294	301	LMB
Philips	GS12	192	85		Philips	LMB	297	364	
Philips	GS13	214	112		Philips	LMB	301	342	LMB7
Philips	GS14	206	94		Philips	LMB	304	359	LMB6
Philips	GS15	213	126		Philips	LMB	317	449	LMB

Appendix G (cont'd). List of sample sites and descriptive statistics for fish species captured in the Industri-Plex Site Ponds, Woburn, Massachusetts, June 1999.

Site	Species	Length (mm)	Weight (g)	Scales	Site	Species	Length (mm)	Weight (g)	Scales
Philips	LMB	326	473	LMB5	Philips	WS	286	227	
Philips	LMB	327	425	LMB	Philips	WS	288	214	
Philips	LMB	330	328	LMB	Philips	WS	288	217	
Philips	LMB	336	567	LMB	Philips	WS	290	241	
Philips	LMB	340	432	LMB	Philips	WS	293	244	
Philips	LMB	345	509	LMB	Philips	WS	294	279	
Philips	LMB	348	525	LMB	Philips	WS	296	287	
Philips	LMB	351	546	LMB	Philips	WS	301	262	
Philips	LMB	376	776	LMB	Philips	WS	314	308	
Philips	LMB	378	675	LMB	Philips	WS	314	323	
Philips	LMB	416	959		Philips	WS	314	NA	
Philips	LMB	461	1264	LMB	Philips	WS	316	313	
Philips	PSS	87	13	PSS5	Philips	WS	316	340	
Philips	PSS	99	15	PSS3	Philips	WS	318	294	
Philips	PSS	109	27	PSS1	Philips	WS	321	324	
Philips	PSS	115	32	PSS4	Philips	WS	325	351	
Philips	PSS	124	44	PSS2	Philips	WS	326	355	
Philips	WS	136	332		Philips	WS	327	342	
Philips	WS	199	85		Philips	WS	327	378	
Philips	WS	205	97		Philips	WS	330	297	
Philips	WS	212	109		Philips	WS	335	369	
Philips	WS	221	118		Philips	WS	337	381	
Philips	WS	224	119		Philips	WS	337	402	
Philips	WS	240	134		Philips	WS	341	407	
Philips	WS	251	156		Philips	WS	352	461	
Philips	WS	254	159		Philips	WS	366	474	
Philips	WS	254	163		Philips	WS	369	467	
Philips	WS	254	172		Philips	WS	369	488	
Philips	WS	255	149		Philips	WS	391	559	
Philips	WS	256	171		Philips	WS	394	565	
Philips	WS	257	182		Philips	WS	400	613	
Philips	WS	258	182		Philips	WS	403	540	
Philips	WS	261	190		Philips	WS	403	647	
Philips	WS	262	181		Philips	WS1	371	480	
Philips	WS	263	195		Philips	WS11	306	278	
Philips	WS	268	200		Philips	WS12	254	155	
Philips	WS	268	208		Philips	WS13	301	251	
Philips	WS	270	189		Philips	WS14	273	215	
Philips	WS	271	185		Philips	WS15	277	209	
Philips	WS	271	206		Philips	WS2	299	268	
Philips	WS	273	228		Philips	WS3	296	249	
Philips	WS	274	199		Philips	WS4	267	173	
Philips	WS	274	220		Philips	WS5	264	177	
Philips	WS	276	218		Philips	WS6	293	228	
Philips	WS	280	210		Philips	WS7	281	215	
Philips	WS	281	208		Philips	WS8	295	243	
Philips	WS	284	220		Philips	WS9	242	148	

Appendix G (cont'd). List of sample sites and descriptive statistics for fish species captured in the Industri-Plex Site Ponds, Woburn, Massachusetts, June 1999.

Site	Species	Length (mm)	Weight (g)	Scales	Site	Species	Length (mm)	Weight (g)	Scales
Pond 3	BB	305	437	BB2	Pond 3	GS	147	43	GS13
Pond 3	BB	337	668	BB1	Pond 3	GS	148	33	
Pond 3	GS	100	11	GS3	Pond 3	GS	149	36	
Pond 3	GS	100	12	GS18	Pond 3	GS	149	39	
Pond 3	GS	102	12	GS4	Pond 3	GS	149	40	
Pond 3	GS	106	12		Pond 3	GS	150	35	
Pond 3	GS	106	12		Pond 3	GS	152	41	
Pond 3	GS	106	13		Pond 3	GS	152	44	
Pond 3	GS	107	11		Pond 3	GS	158	48	GS12
Pond 3	GS	107	13	GS8	Pond 3	GS	158	56	GS7
Pond 3	GS	108	11	GS11	Pond 3	GS	162	62	
Pond 3	GS	110	13		Pond 3	LMB	120	25	LMB1
Pond 3	GS	112	15	GS10	Pond 3	LMB	147	48	LMB3
Pond 3	GS	113	16		Pond 3	LMB	166	62	LMB2
Pond 3	GS	113	17	GS14	Pond 3	PSS	52	2	PSS2
Pond 3	GS	115	16		Pond 3	PSS	78	10	
Pond 3	GS	115	17	GS17	Pond 3	PSS	81	11	
Pond 3	GS	115	18		Pond 3	PSS	84	12	
Pond 3	GS	116	18		Pond 3	PSS	85	9	
Pond 3	GS	117	15	GS20	Pond 3	PSS	85	12	
Pond 3	GS	118	18	GS19	Pond 3	PSS	86	11	PSS5
Pond 3	GS	119	16		Pond 3	PSS	88	13	
Pond 3	GS	119	18	GS2	Pond 3	PSS	88	17	PSS13
Pond 3	GS	119	19		Pond 3	PSS	89	13	PSS6
Pond 3	GS	119	19		Pond 3	PSS	89	16	PSS16
Pond 3	GS	119	23		Pond 3	PSS	90	12	PSS10
Pond 3	GS	120	18		Pond 3	PSS	90	14	
Pond 3	GS	120	19		Pond 3	PSS	90	15	PSS17
Pond 3	GS	121	18	GS5	Pond 3	PSS	90	16	PSS18
Pond 3	GS	123	20		Pond 3	PSS	90	16	PSS20
Pond 3	GS	125	30		Pond 3	PSS	90	16	
Pond 3	GS	126	21		Pond 3	PSS	91	14	
Pond 3	GS	126	25		Pond 3	PSS	92	17	PSS4
Pond 3	GS	126	26	GS15	Pond 3	PSS	92	18	PSS1
Pond 3	GS	126	26		Pond 3	PSS	93	16	
Pond 3	GS	128	26		Pond 3	PSS	94	16	PSS3
Pond 3	GS	128	29		Pond 3	PSS	94	16	PSS11
Pond 3	GS	131	27	GS1	Pond 3	PSS	94	16	PSS19
Pond 3	GS	132	24		Pond 3	PSS	94	17	PSS15
Pond 3	GS	132	24		Pond 3	PSS	95	18	
Pond 3	GS	133	28		Pond 3	PSS	98	16	
Pond 3	GS	133	29		Pond 3	PSS	98	19	PSS14
Pond 3	GS	134	32	GS16	Pond 3	PSS	98	22	PSS7
Pond 3	GS	136	31	GS9	Pond 3	PSS	102	20	PSS12
Pond 3	GS	137	32	GS6	Pond 3	PSS	103	23	PSS9
Pond 3	GS	140	25		Pond 3	PSS	104	24	PSS8
Pond 3	GS	145	37		Pond 3	PSS	105	24	

Appendix G (cont'd). List of sample sites and descriptive statistics for fish species captured in the Industri-Plex Site Ponds, Woburn, Massachusetts, June 1999.

Site	Species	Length (mm)	Weight (g)	Scales	Site	Species	Length (mm)	Weight (g)	Scales
Pond 3	PSS	115	29		Pond 3	WS	255	156	
Pond 3	WS	130	22		Pond 3	WS	255	166	
Pond 3	WS	131	25		Pond 3	WS	256	150	
Pond 3	WS	136	26		Pond 3	WS	256	180	
Pond 3	WS	137	25		Pond 3	WS	257	186	
Pond 3	WS	137	31		Pond 3	WS	259	173	
Pond 3	WS	138	27		Pond 3	WS	260	179	
Pond 3	WS	139	28		Pond 3	WS	262	190	
Pond 3	WS	140	31		Pond 3	WS	264	193	
Pond 3	WS	142	26		Pond 3	WS	267	195	
Pond 3	WS	142	28		Pond 3	WS	271	206	
Pond 3	WS	143	32		Pond 3	WS	272	215	
Pond 3	WS	143	33		Pond 3	WS	279	224	WS6
Pond 3	WS	144	33		Pond 3	WS	290	280	WS3
Pond 3	WS	145	35		Pond 3	WS	292	243	
Pond 3	WS	151	36		Pond 3	WS	323	348	
Pond 3	WS	156	38		Pond 3	WS	327	345	WS1
Pond 3	WS	157	41		Pond 3	WS	332	385	
Pond 3	WS	162	43		Pond 3	WS	333	390	WS10
Pond 3	WS	173	53		Pond 3	WS	334	370	WS5
Pond 3	WS	178	55		Pond 3	WS	358	418	WS2
Pond 3	WS	179	61		Pond 3	WS	387	532	WS9
Pond 3	WS	186	64		South	GS	90	8	
Pond 3	WS	188	60		South	GS	104	11	
Pond 3	WS	190	69		South	GS	105	13	
Pond 3	WS	190	73		South	GS	106	12	GS20
Pond 3	WS	191	65		South	GS	106	13	
Pond 3	WS	192	72		South	GS	107	15	
Pond 3	WS	194	72		South	GS	109	12	
Pond 3	WS	199	82		South	GS	109	14	
Pond 3	WS	200	75		South	GS	109	14	
Pond 3	WS	200	82		South	GS	110	13	
Pond 3	WS	215	99		South	GS	110	14	
Pond 3	WS	215	104		South	GS	111	13	
Pond 3	WS	225	130		South	GS	112	13	
Pond 3	WS	226	115	WS4	South	GS	112	16	
Pond 3	WS	226	127		South	GS	112	17	
Pond 3	WS	231	134		South	GS	114	15	GS6
Pond 3	WS	237	123		South	GS	114	15	GS9
Pond 3	WS	239	126		South	GS	114	16	
Pond 3	WS	241	140		South	GS	114	17	GS18
Pond 3	WS	241	146		South	GS	115	15	
Pond 3	WS	245	151	WS8	South	GS	115	16	
Pond 3	WS	250	158		South	GS	115	16	
Pond 3	WS	253	165		South	GS	115	17	GS16
Pond 3	WS	253	176		South	GS	115	17	
Pond 3	WS	254	162	WS7	South	GS	116	15	

Appendix G (cont'd). List of sample sites and descriptive statistics for fish species captured in the Industri-Plex Site Ponds, Woburn, Massachusetts, June 1999.

Site	Species	Length (mm)	Weight (g)	Scales	Site	Species	Length (mm)	Weight (g)	Scales
South	GS	116	16		South	GS	165	54	
South	GS	117	16	GS7	South	GS	179	73	GS1
South	GS	117	16		South	GS	194	109	
South	GS	118	19		South	LMB	34	1	LMB
South	GS	118	21	GS10	South	LMB	92	10	LMB1
South	GS	118	23		South	LMB	95	10	LMB17
South	GS	119	18	GS13	South	LMB	95	11	LMB7
South	GS	120	17		South	LMB	95	11	LMB18
South	GS	120	17		South	LMB	97	12	LMB16
South	GS	120	18		South	LMB	99	12	LMB13
South	GS	120	20		South	LMB	100	11	LMB15
South	GS	121	18		South	LMB	104	15	LMB3
South	GS	121	21	GS2	South	LMB	104	15	LMB14
South	GS	121	21	GS3	South	LMB	170	61	LMB6
South	GS	122	18		South	LMB	209	111	LMB4
South	GS	123	19		South	LMB	220	143	LMB10
South	GS	123	19		South	LMB	241	215	LMB11
South	GS	123	20	GS5	South	LMB	248	205	LMB8
South	GS	124	19		South	LMB	252	243	LMB9
South	GS	124	20		South	LMB	255	220	LMB12
South	GS	125	19		South	LMB	262	217	LMB2
South	GS	125	21		South	LMB	340	633	LMB5
South	GS	125	23	GS15	South	PSS	60	3	
South	GS	125	25	GS19	South	PSS	60	4	
South	GS	125	27		South	PSS	62	4	
South	GS	126	19		South	PSS	63	4	
South	GS	126	22	GS12	South	PSS	64	5	
South	GS	126	23		South	PSS	65	5	
South	GS	128	24		South	PSS	78	9	PSS13
South	GS	129	24		South	PSS	79	10	
South	GS	131	26	GS14	South	PSS	80	10	PSS15
South	GS	131	26		South	PSS	80	10	
South	GS	132	25		South	PSS	81	10	PSS8
South	GS	133	28		South	PSS	81	12	
South	GS	134	25	GS4	South	PSS	82	11	
South	GS	135	23	GS11	South	PSS	82	11	
South	GS	135	28		South	PSS	82	11	
South	GS	136	25		South	PSS	83	10	PSS3
South	GS	136	30	GS8	South	PSS	84	10	
South	GS	138	31		South	PSS	84	11	
South	GS	139	29	GS17	South	PSS	85	11	
South	GS	142	32		South	PSS	85	13	
South	GS	146	36		South	PSS	85	13	
South	GS	152	35		South	PSS	85	14	
South	GS	153	45		South	PSS	85	15	
South	GS	160	63		South	PSS	86	12	PSS14
South	GS	163	52		South	PSS	86	12	

Appendix G (cont'd). List of sample sites and descriptive statistics for fish species captured in the Industri-Plex Site Ponds, Woburn, Massachusetts, June 1999.

Site	Species	Length (mm)	Weight (g)	Scales	Site	Species	Length (mm)	Weight (g)	Scales
South	PSS	86	14		South	PSS	95	18	
South	PSS	87	12		South	PSS	95	18	
South	PSS	87	13		South	PSS	95	18	
South	PSS	87	14		South	PSS	95	18	
South	PSS	88	13	PSS16	South	PSS	95	20	
South	PSS	89	16		South	PSS	96	16	
South	PSS	90	13		South	PSS	96	16	
South	PSS	90	14	PSS10	South	PSS	96	17	PSS5
South	PSS	90	14		South	PSS	96	17	
South	PSS	90	14		South	PSS	96	17	
South	PSS	90	14		South	PSS	96	18	
South	PSS	90	14		South	PSS	96	19	PSS12
South	PSS	90	14		South	PSS	97	19	
South	PSS	90	14		South	PSS	97	19	
South	PSS	90	15		South	PSS	97	20	
South	PSS	90	15		South	PSS	98	19	PSS7
South	PSS	90	15		South	PSS	98	19	
South	PSS	90	15		South	PSS	100	19	
South	PSS	90	15		South	PSS	100	20	PSS4
South	PSS	90	15		South	PSS	100	21	
South	PSS	90	15		South	PSS	101	20	PSS11
South	PSS	91	15	PSS17	South	PSS	102	23	
South	PSS	91	15		South	PSS	103	23	
South	PSS	91	15		South	PSS	104	25	PSS1
South	PSS	91	16		South	PSS	105	21	
South	PSS	91	16		South	PSS	105	22	
South	PSS	92	14	PSS18	South	PSS	106	28	
South	PSS	92	14		South	PSS	109	21	
South	PSS	92	14		South	PSS	112	32	
South	PSS	92	14		South	PSS	115	30	
South	PSS	92	15	PSS2	South	PSS	116	36	
South	PSS	92	15	PSS6	South	PSS	120	43	
South	PSS	92	15	PSS9					
South	PSS	92	15						
South	PSS	92	16						
South	PSS	92	16						
South	PSS	92	16						
South	PSS	92	16						
South	PSS	92	17						
South	PSS	93	14						
South	PSS	93	17	PSS19					
South	PSS	93	17						
South	PSS	94	16						
South	PSS	94	17	PSS20					
South	PSS	94	18						
South	PSS	95	17						
South	PSS	95	18						

United States Department of the Interior
Fish and Wildlife Service

CENTRAL NEW ENGLAND
FISHERIES RESOURCE COMPLEX
151 Broad Street
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March 15, 2001

Mr. Joseph F. LeMay, P.E.
Remedial Project Manager
Office of Site Remediation and Restoration
US Environmental Protection Agency
1 Congress Street, Suite 1100
Boston, Massachusetts 02114-2023

Dear Mr. LeMay:

This letter addresses the draft comments that were received from the Environmental Protection Agency (EPA) and its contractor (TTNUS) regarding the U.S. Fish and Wildlife Service (FWS) "Draft Fishery Survey, Industri-Plex Site, Woburn, Massachusetts." Thirteen comment items were identified and have been addressed. In addition, comments received on the report from EPA's ecological risk assessor have been considered in formulating responses to Items 4 and 10.

A physical habitat assessment of each of the ponds was not conducted as part of this fishery survey and therefore habitat, vegetation, and structure in the ponds was not quantified (Item 1). The area, depth, and water quality characteristics described for the ponds in the report were obtained from other documents that included this information. The fact that fish were observed and captured in the ponds suggests that habitat is at least marginally suitable for spawning and production. It is noted that greater species diversity in a pond suggests enhanced habitat suitability for robust fish species assemblages. Hence, species composition for each pond is shown in Figures 5 - 8 in the report. Beaver activity in Phillips Pond had raised the pond water level elevation an estimated two feet at the time of this fish survey and it has been noted in the report (Item 2). The resultant flooding likely increased the area in the littoral zone and perhaps boat electrofishing was not as efficient in this near shore zone.

I have clarified the intent of the objectives stated in the Introduction to note that the report provides specific data relevant to objectives a. through d., and fish specimens collected during the survey will also be used to address objectives e. and f. (Item 3).

All references to the impacts of chemical contamination on fish health and fish population structure have been deleted from the report. The report does not address chemical contamination in the ponds, chemical concentrations in fish tissues, or impacts of these contaminants on fish (Item 4).

At the time of this survey drought conditions had persisted across the State of Massachusetts for quite some time, and it is now noted in the report that this regional weather/climatic event may have altered water levels and water temperature in HBHA Pond, HBHA Pond No. 3 and South Pond (Item 5). In Tables 7 and 8, Proportional Stock Density (PSD) and Relative Stock Density (RSD) values for bass in the Site ponds are compared to other waterbodies in New Hampshire and Connecticut. It is recognized that the waterbodies used for comparisons are significantly larger than the ponds at the Site, however values presented were the only data found to be available (Items 6 and 7). A Summary and Conclusions section has been added to the report and information included in the body of the report addressing physical habitat quality features of the ponds with respect to their ability to support different fish species (Items 8 and 9).

An earlier statement indicating "it is possible that small bass were overlooked due to the directed effort at capturing large fish to ensure adequate tissue samples for laboratory analysis" has been revised. The text now reads: "At the time of this survey drought conditions had persisted across the State of Massachusetts. The surface water table was extremely low, particularly for HBHA Pond No.3 and South Pond. Such conditions may have negatively affected aquatic habitat and abundance of fish in the ponds. Stock structure indices for both HBHA Pond No. 3 and South Pond may also have been affected by minor sample bias. Some small fish of all species, though observed, were not captured in these ponds. It is possible that a few small (≈ 150mm) bass were misrepresented as other species and thus overlooked or not captured due to the directed effort at capturing larger fish (>150mm) to ensure adequate tissue samples for laboratory analyses." It should be noted that only bass ≥150mm were used to develop PSD values for the ponds and thus values would not be effected if smaller bass were overlooked. In addition, it is likely that very few small bass were overlooked and therefore species composition figures should be quite accurate (Item 10).

Review comments addressing the function of HBHA Pond as a retention basin, and the fact that individuals have been observed fishing and perhaps consuming fish at sites near the pond are acknowledged (Items 11 and 12). Lastly, the three concluding paragraphs in the draft document discussing recreational angling opportunities have been deleted from the report (Item 13).

In our telephone conference on February 27, 2001 you asked if I could address an issue related to fish consumption rates given that EPA staff had observed fishing camps on HBHA Pond. The fishery survey was not designed to directly address this request, and since there is not an accurate evaluation of how much fish and what types of fish anglers are ingesting, fish ingestion rates would need to be estimated. Three possible scenarios were presented for consideration: a) one 6 ounce fish meal per week for 7 months/year = total of 4759 grams of fish/year and a total of 168, 6 ounce fish meals/year; b) one 8 ounce fish meal per week for 7 months/year = total of 6345 grams of fish/year and a total of 224, 8 ounce fish meals/year; and c) two 8 ounce fish meals per week for 7 months/year = total of 255550 grams/year and a total of 56, 8 ounce fish meals/year.

Based on the species and size of fish captured in HBHA Pond (Appendix G) it seems reasonable to assume that subsistence anglers would target largemouth bass, white sucker or brown bullhead for consumption. While the numbers of bullhead (3) and bass (9) captured in HBHA Pond were limited, a moderate number of white suckers (57) were captured, and the percent composition of this species in the pond as well as in HBHA Pond No. 3, located not too distant downstream from HBHA Pond, was quite similar. Accordingly, it is not unreasonable to assume that HBHA Pond could support a harvest rate that would achieve scenario (b) in a single year: one 8 ounce fish meal per week for 7 months/year = total of 6345 grams of fish/year and a total of 224, 8 ounce fish meals/year. Since the survey was not designed to develop population estimates or age structure of fish species in the ponds, it is not possible to determine whether this annual yield would be sustained for the three fish species individually or in aggregate given the stated harvest or exploitation rate.

Thank you for the opportunity to assist your agency in understanding the fish population and community structure in the ponds located adjacent to the Industri-Plex Site. I have incorporated comments and suggestions into the fishery survey report and if you have questions please contact me at your convenience at (603) 528-8750.

Sincerely,

Joseph F. McKeon

Joseph F. McKeon
Supervisory Fishery Biologist

cc: Munney, K., USFWS, NEFO
Meirzycowski, S., USFWS, MEFO

attachments

EPA Draft Comments on
U.S. Fish and Wildlife Service's
Draft Fishery Survey at Industri-Plex Superfund Site,
Woburn, Massachusetts, dated April 2000

1) General (TTNUS): A physical description of each pond including general condition, acreage, water depths, spawning habitat presence, vegetation types, structure, etc., would be useful for data assessment.

2) General (TTNUS): It should be noted that beaver activity at Phillips Pond had raised the pond water level an estimated 2 feet or more at the time of the fish survey. This should be taken into consideration during the discussions. The resultant flooding had significantly increased the littoral area in Phillips pond.

3) Page 1, Introduction, a.- f (TTNUS): These objectives are somewhat misleading and give the reader the impression that all these objectives are addressed in this report. This section should be clarified or state that these objectives are being accomplished by Menzi-Cura through the Final GSIP Ecological Risk Assessment. Specifically, Objectives e.) and f.) are not addressed in the draft version of the report and some portions of the other objectives are not complete.

4) Page 8, 1st paragraph (TTNUS): The last phrase indicates that the lack of abundance of smaller bass could be due to "the impacts of chemical contamination". This report does not address chemical contamination in the ponds, chemical concentrations in fish tissues, or the impacts of these contaminants. This phrase should be removed from the text. The text should explain that the impacts of chemical contamination will be evaluated under the ecological and human health risk assessments.

5) Page 8, Results and Discussions: The document needs to record the weather/ climatic conditions encountered during the June 1999 Fishery Survey. During the Spring and early Summer, drought conditions were encountered across Massachusetts during the Fishery Survey. The surface water table was extremely low during the survey, especially for the shallow HBHA Pond 3 and South Pond. The drought conditions should be documented and discussed in the report. The drought conditions may have impacted fish population, size and diversity fish collected/observed during the survey. Please elaborate in the document.

6) Results and Discussion section, Tables 7 and 8 (TTNUS): In the tables there are comparisons of Proportional Stock Density (PSD) and Relative Stock Density (RSD) values observed in the Industri-plex site ponds to other water bodies in New Hampshire and Connecticut. With the exception of Mass Cove on the Connecticut River, all water bodies used for comparison are significantly larger than those at the Industri-plex site. It would be more useful to present data from comparatively-sized ponds in relatively similar environmental settings (urban vs. rural), if available.

7) Results and Discussion section, Table 8 (TTNUS): It states that the New Hampshire ponds

were "selected" for comparison to Industri-plex. The basis for selection of these ponds should be stated in the discussion.

8) Results and Discussion section (TTNUS). The section is somewhat fragmented. The final paragraph section should summarize the factors observed at the site ponds that may be impacting the fish populations (i.e. shallow depth, lack of suitable/sufficient vegetation in the littoral zone, lack of irregular shoreline and submerged structures, dissolved oxygen concentration, etc.).

9) Results and Discussion section (TTNUS): The section should also present a discussion of how the observed physical conditions at the Industri-plex site ponds may impact fish species other than small/largemouth bass. This would fully address Objective C. - "generally evaluating physical habitat quality features of the ponds with respect to their ability to support different fish species".

10) Page 10, 1st paragraph (TTNUS): The statement "It is possible that small bass were overlooked due to the directed effort at capturing large fish to ensure adequate tissue samples for laboratory analysis" is troubling. This statement leads the reader to think that the discussions and comparisons presented in Tables 7 and 8 may also be inaccurate because of a sampling bias that targeted larger fish. The impacts of the sample bias should be considered in all aspects of the Results and Discussion section.

11) Page 10, Results and Discussions: The text states, "If the HBHA Pond functions as a retention basin, water levels may fluctuate in spring due to runoff from snow melt and storm events, as well as, increased impermeability around the site. Frequent events may also result in water fluctuations that reduce prey availability for juvenile and adult base life stages." Based upon my observations of the water levels within the HBHA Pond, I do not believe the HBHA Pond is serving as typical retention basin, and I do not believe the water levels significantly fluctuate. Based upon the GSIP Phase 1 and 2 reports and visual observations of the HBHA Pond, a majority of the water in the pond is a result of groundwater discharge. Over the years, I have not observed significant surface water level fluctuations within the HBHA Pond. I estimate the surface water level within the pond may fluctuate up to 2 feet over an average one year period. With regard to increased impermeability around the site, at the time of the survey their should not have been an increase impermeability around the site. The 36 acre Regional Transportation Center Alternative Cover immediately to the north of the HBHA Pond was covered with crushed stone, which would have increased permeability. Three of the four animal hide piles located north of the HBHA Pond were covered with permeable covers, which would not have changed the permeability significantly prior to the remedy. The most significant surface water discharge into the HBHA Pond is from Halls Brook (west side of pond). This brook discharges approximately 1/3 of the distance from the northern boundary of the pond. It is possible that high flow events may increase turbidity near this discharge, and possibly affect eggs and fry near the discharge area.

12) Page 11, Results and Discussions: The text states, "Given the size of bass observed in the ponds, the potential for harvesting fish in a recreational fishery is limited. ... The number and size of bass observed in HBHA Pond limits the potential for recreational angling opportunities."

In the Spring 2000, EPA observed and photographed a camp established along the northern bank of the HBHA Pond (under the Boston Edison ROW) for fishing. According to the Woburn Police Department (WPD), they regularly observe ethnic populations (Asian Heritage) fishing in HBHA Pond, cooking fish on an open fire along the northern bank of the HBHA Pond, and consuming the cooked fish. EPA will attempt to interview the WPD and document this matter further.

13) It is suggested that the last three paragraphs of the Results and Discussion section should be removed from the Fish Survey. The objectives of this study did not include providing recommendations for improving recreational opportunities. On the contrary, recreational fishing is discouraged until studies are completed that assess human health risk exposure to potentially contaminated sediments at the shoreline and/or through fish consumption.

U. S. ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND
OFFICE OF ENVIRONMENTAL MEASUREMENT & EVALUATION
OFFICE OF ECOSYSTEM ASSESSMENT
60 WESTVIEW STREET, LEXINGTON, MA 02421

MEMORANDUM

DATE: July 5, 2000

SUBJ: Review of *Draft Fishery Survey, Industri-Plex Site, Woburn, Massachusetts*

FROM: Patti Lynne Tyler
Aquatic Biologist/Ecological Risk Assessor

TO: Joe LeMay
Remedial Project Manager

Thank you for the opportunity to review and provide technical comments on the above referenced document. Comments are attached to this memorandum. Please do not hesitate to contact me should you have any questions or comments with respect to this review.

cc: Peter Nolan EPA/OEME/ECA

Review and Technical Comments on Draft USFWS Document:
Fishery Survey at Industri-Plex, Woburn, Massachusetts

1. 0 Introduction

This report documents fish populations and community structure at two small ponds adjacent to the Industri-Plex Superfund site. The ponds were extremely small in surface area (1.9 and 0.6 ha) and were compared to two similar-sized reference ponds of 2.3 and 0.5 ha.

The fishery survey was undertaken to identify the composition and general abundance of fish in the Halls Brook Holding Area Pond (HBHA Pond) and Halls Brook Holding Area Pond No. 3 (HBHA Pond No. 3), and compare these ponds with two reference ponds identified as South Pond and Phillips Pond. The survey included collection of fish through electro-shocking, gill-netting, and trapping, as well as an evaluation of habitat characteristics of each pond to assist in interpreting fish abundance data. Fish tissue samples were also collected for chemical analysis. The analysis data from these fish samples will be used in the human health and ecological risk assessments for the site.

2.0 General Comments

The authors concluded that relative weights of bass for all 4 ponds suggests that these ponds do not support reasonably balanced bass populations and lack the larger size classes (memorable 510-629 mm and trophy 630+). Despite extremely small sample sizes of bass for each pond (1, 9, 9, and 37), the authors speculated that there was a lack of abundance of smaller bass due to poor quality habitat and/or chemical contamination. However, the authors also noted that possible sample bias may have caused smaller size classes of fish to be under-sampled since larger fish were also desired for tissue sampling.

The sampling bias toward larger fish and the overall small sample size may have resulted in an underestimate of smaller bass in the HBHA and HBHA No. 3 ponds. If their small sample size was really indicative of the true population structure, the paucity of smaller bass could be due in part to chemical contamination as noted by the authors. It must be noted, however, that numerous other stressors might contribute to a small population of smaller bass, including the following:

- small pond volumes allowed easy predation by larger bass, piscivorous birds (Kingfishers, Osprey, Herons, Mergansers, Loons, Cormorants, Grebes), and piscivorous mammals (mink, river otters)

- ponds lacked adequate escape cover from larger bass and avian and mammalian predators

offer little vegetative structure for cover, and an abundance of fish such as suckers that will eat the eggs of other fish. Subsistence fishing may occur in these ponds, as such fishing is not necessarily in compliance with minimum catch sizes or limited to "desirable " species. Similarly, food chain effects to piscivorous birds and mammals could occur if chemicals are accumulating in the tissues of fish in these ponds. The fish tissue data will be useful for evaluating the possible food chain effects of any accumulated chemicals. The tissue data can also be compared with tissue residue data associated with adverse effects on the fish themselves, which could provide additional insight into the combination of physical and chemical stressors at work in these ponds.

- scarcity of optimal overwinter habitat (>5.5 m deep) might have concentrated all fish into small areas where predation would be high
- ponds lacked adequate spawning habitat
- unknown water fluctuations and stormwater runoff impacted nests/eggs
- egg and fry predation by numerous suckers, sunfish, and golden shiners
- reported low DO levels (< 4 mg/L) in late summer would kill or concentrate fish into small areas where predation would be high

With the possibility of all these factors in operation, speculation about adverse affects from chemical contamination is unwarranted without actual levels of pollutants from tissue samples. Overall, this report profiles two very small ponds with poor habitat for largemouth bass and few conclusions should be drawn considering the extremely small sample sizes of bass in each pond. In addition to bass, prey species populations of golden shiner, white sucker, and sunfish also showed a severely truncated distribution of smaller juveniles. This observation supports the premise of sampling bias for larger fish and may also support the notion that overpredation may be occurring due to the small pond volumes and lack of suitable escape cover.

3.0 Conclusions

Part of the purpose of this fishery survey was to evaluate the habitat conditions offered by the HBHA Pond and HBHA No. 3 Pond, and to identify the potential of each pond to support a recreational fishery. In spite of the sampling bias towards larger fish, this survey presents a reasonable evaluation of the fishery potential for each pond.

It appears that both ponds offer poor habitat for recreational species. Both ponds would provide marginal over-wintering areas under best of circumstances, and both ponds offer little vegetative structure for cover, and an abundance of fish such as suckers that will eat the eggs of other fish. Subsistence fishing may occur in these ponds, as such fishing is not necessarily in compliance with minimum catch sizes or limited to "desirable " species. Similarly, food chain effects to piscivorous birds and mammals could occur if chemicals are accumulating in the tissues of fish in these ponds. The fish tissue data will be useful for evaluating the possible food chain effects of any accumulated chemicals. The tissue data can also be compared with tissue residue data associated with adverse effects on the fish themselves, which could provide additional insight into the combination of physical and chemical stressors at work in these ponds.